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GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION

PROJECT INITIATION

Date: May 9, 1975

Project Title: Poultry Processing and Waste Utilization Research

Project No.: A-1737

Project Director: Mr. Jerry L. Birchfield

Sponsor: Georgia Dept. of Agriculture, Atlanta, Georgia

Agreement Period: From April 15, 1975 Until April 14, 1976

Type Agreement: Standard Industrial Agreement

Amount: $125,000

Reports Required: Monthly Progress Letters; Annual (Final) Technical Report

Sponsor Contact Person:

Mr. Hubert F. Jordon, Jr.
Fiscal Resources Officer
Georgia Dept. of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

NOTE: Follow-on to A-1659

Assigned to: TECHNICAL SUPPORT DEPARTMENT

COPIES TO:

Project Director
Director, EES
Director, ORA/GTRI
Assistant Director
Division Chief
EES Accounting
Patent Coordinator

EES Supply Services
Photographic Laboratory
Security—Reports—Property Office
General Office Services
Library, Technical Reports Section
Office of Computing Services
Project File
Other ~~Sue Corbin; Bonnee Wettlaufer~~

RA-3 (3-75)

no action
OCA

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: August 30, 1976

Project Title: Poultry Processing and Waste Utilization Research

Project No: A-1737

Project Director: J. F. Lowry

Sponsor: Georgia Department of Agriculture

Effective Termination Date: June 30, 1976

Clearance of Accounting Charges: N/A - all funds expended *

Grant/Contract Closeout Actions Remaining:

*Overrun to be transferred to Laboratory account.

- X Final Invoice ~~and Closing Documents~~
- _ Final Fiscal Report
- _ Final Report of Inventions
- _ Govt. Property Inventory & Related Certificate
- _ Classified Material Certificate
- _ Other ______________

Follow-on project is A-1879.

Assigned to: Productivity/Technology Applications (~~School~~/Laboratory)

COPIES TO:

Project Director	Library, Technical Reports Section
Division Chief (EES)	Office of Computing Services
School/Laboratory Director	Director, Physical Plant
Dean/Director—EES	EES Information Office
Accounting Office	Project File (OCA)
Procurement Office	Project Code (GTRI)
Security Coordinator (OCA) ✓	Other ______________
Reports Coordinator (OCA)	

CA-4 (3/76)

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

July 15, 1975

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737 for Period 1 June 1975 to 1 July 1975.

Dear Mr. Jordan:

This monthly letter report summarizes activities on project A-1737 directed to:

1) Development of poultry processing equipment,
2) Generation of methane from poultry wastes,
3) Improving turkey harvesting techniques,
4) Evaluating additional needs for processing equipment in poultry processing plants, and
5) Evaluating critical energy factors in the poultry industry.

During this period technical activities on (1) above involved redirection of the transfer equipment design philosophy from that of the rotating arm-hand assembly to the containerized transfer mechanism. Several briefings with industry and the Department of Agriculture personnel have been held to discuss this alternative approach. During the next period design activities will continue and other briefings will be held to keep you and the industry fully informed on progress.

The waste utilization program continued with build-up and installation of 6-5 gallon digestor units to evaluate pressure, temperature and gas effects on gas generation rates. Planning for a 5000 to 10,000 gallon pilot facility for methane generation was continued. The plant was sized to overcome size sensitive parameters and fall within reasonable fiscal constraints. A site for this facility was selected at a layer farm in Cumming, Georgia. The fiscal 1976 budget was prepared for this project.

A meeting was held with representatives of the Georgia Turkey Farmers Association to discuss (3) above. Problem areas were defined and the scope of the effort was centered on improving existing loading equipment. An individual with a patented automatic loading system was located in Wisconsin and this system is being investigated for application to the local problems.

Effort was initiated in 4) above with 3 plant visits to typical processing plants. As a result of this preliminary work and discussion with industry representatives it has been decided to concentrate our efforts in area of automatic packaging system.

Evaluation of critical energy factors proceeded with plant visits to four major facilities in Gainesville and Cornelia acquiring energy use and process data.

During July the efforts on all programs will be a continuation of those discussed.

Respectfully submitted,

for Jerry L. Birchfield
Project Director

mh

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

August 15, 1975

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737 for Period 1 July 1975 to 1 August 1975

Dear Mr. Jordan:

This monthly letter report summarizes activities on project A-1737 directed to:

1) Mechanized poultry transfer,
2) Generation of methane from poultry wastes,
3) Improved turkey harvesting techniques,
4) Evaluation of packaging equipment needs in poultry processing plants,
5) Evaluation of critical energy factors in the poultry industry.

During this period activities on (1) above were directed to an intense reevaluation of the rotating hand-arm and containerized transfer system. Meetings were held with the automation subcommittee to brief that group of our progress. Subsequently, it was decided to devote the next several months to a critical review of the container transfer system and to integrate this activity with efforts in development of mechanized poultry packaging equipment.

The waste utilization program continued with completion of the build-up of 6-5 gallon laboratory digestor units to evaluate pressure, temperature and gas effects on gas generation rates. During the next monthly period instrumentation will be calibrated and the digestors will be charged with feedstock. Planning for the design of the 5,000 to 10,000 gallon pilot facility was completed and we are awaiting approval of the fiscal 1976 contract to begin purchasing hardware for installation at a Cumming, Georgia site.

Relative to (3) above the patented Wisconsin/loading system was visited. This system effectively alleviates the loading problems cited by the Georgia Turkey Farmers Association. This potential, available solution was presented to representatives of the association with the recommendation that a system should be purchased by their group. This loader would in turn be modified by EES/GIT to further ease the loading problem and to aid in developing operational procedures. The group will evaluate various alternatives and another meeting will be scheduled for mid August.

Three plant visits were conducted in project (4) above to measure and evaluate packaging needs. This activity will continue during the next period.

Evaluation of critical energy factors continued with plant visits to eight plants in Athens, Canton, Dalton, Macon, Buena Vista, Tifton, Camilla, Douglas and Metter to acquire energy use data and observe plant processes. Data analysis and evaluation of alternate energy sources was begun.

Respectfully submitted,

Jerry L. Birchfield
Project Director

ct

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

September 4, 1975

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737 for Period 1 August 1975 to 1 September 1975.

Dear Mr. Jordan:

This monthly letter report summarizes activities on project A-1737 directed to:

1) Mechanized poultry transfer,
2) Generation of methane from poultry wastes,
3) Improved turkey harvesting techniques,
4) Evaluation of packaging equipment needs in poultry processing plants,
5) Evaluation of critical energy factors in the poultry industry.

During this period efforts on (1) above were devoted to a reassessment of the containerized transfer technique and obtaining industry input on future directions in this area. This evaluation work will continue during the next two periods before a final direction is established and design, test and evaluation activities are reinitiated.

The waste utilization program continued with calibration of instrumentation for the 5 gallon laboratory digestors. Trouble developed with the new gas chromatograph requiring complete recalibration. This equipment will allow for automatic, periodic sampling of gas composition and gas production rate, Because of this delay feedstock charging will be delayed until the beginning of the next reporting period. Authorization to proceed with the 10,000 gallon digestor pilot facility was received on August 15 and was designated project A-1771. Purchase of holding, mixing and digestor tanks were initiated. Drawings and further purchasing will be completed during the next period. This work will be reported henceforth as A-1771.

Relative to (3) above a visit was made to North Carolina to view the Bright loading system and other loading system modifications. Gerome foods in Wisconsin was contacted regarding their interest in our effort. A meeting was held with representatives of the Georgia Turkey Growers Association at which time it was decided that EES would receive preliminary drawings on the Gerome loader, modify the top to add a telescoping motion and the bottom to add a preloading mechanism. From these plans Gerome Foods will build a prototype and the Georgia Turkey Growers Association will build a prototype for EES to develop in actual operation. The next period will be utilized in acquiring drawings from Gerome Foods.

Two plant visits were conducted in project (4) above to measure packaging needs. A detailed layout of the packaging operation was initiated. Evaluation of this layout will continue next period.

Evaluation of critical energy factors continued with plant visits to GoldKist, Central Soya, Wilson & Co. and Eastern Pullets to acquire energy use data. Analysis of these data and alternate energy uses continued.

Respectfully submitted,

J. L. Birchfield
Project Director

mh

Approved By: ______________________

R. L. Yobs
Laboratory Director

A-1737

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

October 3, 1975

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737 for Period 1 September 1975 to 30 September 1975

Dear Mr. Jordan:

This summarizes activities on Project A-1737 with tasks designated as follows:

000 Mechanized poultry transfer
001 Methane generation for Waste Utilization
002 Improved turkey harvesting techniques
003 Evaluation of packaging equipment needs in poultry processing plants
004 Evaluation of critical energy factors in the poultry industry.

Task 000

Evaluation and reassessment of the containerized transfer technique continued with evaluation of the accumulating mechanism for handling the differential line speed between the eviscerate and kill lines. This evaluation will continue through the next period in establishing a final direction for the project.

Task 001

Efforts on the 5 gallon laboratory digestors continued with the set-up and loading process. The gas sampling instrument was returned to the factory for repair and has been received back at the laboratory. The digestors were loaded with feedstock of manure and water but various test facility leaks occurred which necessitated redesign of the gas flow system. This is currently being redesigned and the digestors will be recharged during the next period.

Task 002

A second meeting was held with the Georgia Turkey Farmers Association (GTFA) to determine the various alternatives of adapting the Jerome Foods turkey loader to their problem. The GTFA group agreed that EES will acquire the rough sketches available of the Jerome loader, modify these to include a telescoping direct loading device and add a preloading system to get the turkeys on to the conveyor belt. Engineering drawings will be made for the resulting loader and one set will be sent to Mr. Jerome for fabrication and test. The GTFA will also retain a set of drawings and have a loader fabricated for their own field test. The sketches are currently awaited to begin engineering design during the next period.

Task 003

Plant visits and data evaluation were continued. A flow diagram and labor timing study was conducted to establish base line information.

Task 004

Data acquisition of energy use data was completed and analysis was continued. Several energy conservation ideas were investigated and evaluated. A series of energy seminars are planned and the initial seminar is scheduled for October 28, 1975 in Gainesville.

Respectfully submitted,

James F. Lowry
Project Director

Approved by: ____________________
R. L. Yobs
Laboratory Director

mh

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

November 4, 1975

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

SUBJECT: Monthly Progress Summary Letter for EES/GIT Project A-1737 for Period 1 October 1975 through 31 October 1975

Dear Mr. Jordan:

This summarizes activities on Project A-1737 with tasks designated as follows:

000 Mechanized poultry transfer
001 Methane generation for Waste Utilization
002 Improved turkey harvesting techniques
003 Evaluation of packaging equipment needs in poultry processing plants
004 Evaluation of critical energy factors in the poultry industry.

Task 000

Evaluation and reassessment of the containerized transfer system was completed and an advisory committee has been scheduled in the next period to report to the poultry industry. It is anticipated that the direction and scope for further work will be obtained during this advisory meeting.

Task 001

Design and component procurement for the 10,000 gallon digestor in Cumming, Georgia continued. All major, lead-time items have been ordered. Several components have been delivered and site preparation has begun. Engineering drawings for the facility are essentially complete. Next period will evidence continued assembly and installation.

Five 5-gallon laboratory digestor systems have been assembled, leak checked and pronounced completed for evaluation of the digestion process under several controlled conditions. This laboratory effort has taken more effort than originally planned because of plumbing and instrumentation difficulties associated with operating in an oxygen free atmosphere. These have been overcome and the digestors will be charged in the next period with little detrimental effect on the operation of the large digestor.

Task 002

During last period the Jerome Foods' drawings of their turkey loader were requested and these were received at the end of this period. Preliminary review indicates these are very incomplete resulting in a much greater design effort than originally intended. This will be evaluated and work begun during the next period.

Task 003

A report on the preliminary results of several data gathering site visits was prepared with the results to be discussed during the upcoming advisory committee meeting to ascertain the direction of effort in the packaging area. This meeting will be held during the next period.

Task 004

Completed data analysis of information gathered during previously conducted site visits and completed preparation of a seminar presentation. Held first seminar in Gainesville on October 28th and presented results of the audit to members of the industry. Thirty-five industry members attended. A copy of the Poultry Times article on the seminar is included for your information. These seminars will continue to be conducted throughout the state.

Respectfully submitted,

J. F. Lowry
Project Director

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mh

A - 1737

ENGINEERING EXPERIMENT STATION

GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

December 2, 1975

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737 for Period 1 November 1975 through 30 November 1975

Dear Mr. Jordan:

This summarizes activities on Project A-1737 with tasks designated as follows:

- 000 Mechanized poultry transfer
- 001 Methane generation for Waste Utilization
- 002 Improved turkey harvesting techniques
- 003 Evaluation of packaging equipment needs in poultry processing plants
- 004 Evaluation of critical energy factors in the poultry industry

Task 000

A meeting was held with Mr. Jack Ellerbee, Chairman of the Tech Advisory Committee and Abit Massey and it was agreed the development of the containerized transfer system would be more costly and time consuming than the funds or time remaining in the contract. Therefore it was decided to evaluate several ideas that members of the Advisory Committee have and settle on one or more of these for conceptual study. Definition of these ideas will be accomplished on December 16, 1975 when a full advisory committee meeting is scheduled.

Task 001

Installation of the 10,000 gallon digester in Cumming, Georgia is continuing. Engineering drawings are complete, most components have been delivered, grading and cement work is complete and component assembly will begin early next period.

The 5-gallon laboratory digesters were charged early in the period and the incubation period started. Preliminary data analysis indicates that hydrogen head gas increases the rate of incubation and that the gas rate of production is higher for thermophilic (135°F) operation than mesophilic (95°F). Late in the period, leaks through the pressure switches were discovered and the manufacturer has agreed to furnish leak free switches. The next period will be used to install the new switches.

Task 002

Design work is continuing on the turkey loading device using Jerome Foods' basic design. There are no electrical or hydraulic schematics available from Jerome and these along with the translating top loader will have to be completely designed. This requires a greater effort than originally planned and will effect the results at the end of the contract period. This design effort will continue through next period.

Task 003

As a result of the meeting with Mr. Ellerbee and Mr. Massey discussed in Task 000, it was agreed to redirect the efforts in the packaging area to a solar/broiler house demonstration project. It will be the purpose of this effort to design and install a solar heating system in a broiler house and evaluate its operation during the 1975-1976 winter months. A contract grower for Wilson and Co. has agreed to provide his facility and design work is proceeding. Designs will be completed this next period with construction to begin after January 1, 1976.

Task 004

Updated energy audit data based on new cost figures and scheduled a Middle/South Georgia seminar for December 9, 1975 at ABAC in Tifton. Prepared a technical article to be published in the January issue of Broiler Industry, a trade publication, with the subject of energy use and conservation measures in the Georgia poultry industry. This should widely disseminate the information derived during the study.

Respectfully submitted,

James F. Lowry
Project Director

JFL:sm

R. L. Yobs, Lab Director

A-1737

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

January 2, 1976

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737 for Period 1 December 1975 through 31 December 1975

Dear Mr. Jordan:

This summarizes activities on Project A-1737 with tasks designated as follows:

000 Mechanized poultry transfer
001 Methane generation for Waste Utilization
002 Improved turkey harvesting techniques
003 Evaluation of packaging equipment needs in poultry processing plants
004 Evaluation of critical energy factors in the poultry industry

Task 000

A poultry industry advisory committee meeting was held on December 16, 1975 to discuss various aspects of industry mechanization and to derive areas of interest for further mechanical design efforts. The areas considered by the committee to be critical to the industry are as follows:

1) Broiler catching, hauling and unloading systems.
2) Automated packing of whole birds at the end of the process line.
3) Bird counting systems in the processing plants.
4) Noise abatement studies and education.
5) Reduction of BOD, COD and grease concentration in waste water.
6) Turkey loading mechanism.
7) Utilization of poultry manure.
8) Selling of eggs by the pound instead of by the dozen.

After much discussion it was agreed that conceptual studies will be conducted of items #1 and #2 during the period from January through June 1976. From these studies will be determined the feasibility of finding a solution to the problem and the approximate cost in dollars and manhours for such an effort. These conceptual studies will be internally funded by the Engineering Experiment Station.

Task 001

Installation of the 10,000 gallon digester in Cumming, Georgia is continuing. Mechanical installation is estimated to be 80 percent complete and electrical hookup has begun. Several critical items have not been delivered as scheduled; however, these problems are being solved as they arise. Hookup and checkout will continue next month.

The 5-gallon laboratory digester system has been prepared for valve installation but the valves have not arrived as scheduled. These are anticipated the next period.

Task 002

Design work is continuing on the turkey loading system. The basic concept has been decided and calculation for support member sizing and bearing loadings are in progress. This effort will continue through the next period.

Task 003

Agreement was obtained from Mr. Jordan to transfer this effort to the solar/broiler house application and the work has been redirected to this area. Preliminary design has been completed relative to the solar collector. Finalized designs including duct work will be completed next period.

Task 004

An energy audit seminar was held at Abraham Baldwin Agricultural College in Tifton to disseminate the results of the recently completed energy audit of the poultry industry. This completes the efforts planned under this task with the exception of report preparation.

Respectfully submitted,

James F. Lowry
Project Director

R. L. Yobs, Laboratory Director

mh

A-1737

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

February 3, 1976

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737
for Period 1 January 1976 through 31 January 1976

Dear Mr. Jordan:

This summarizes activities on Project A-1737 with tasks designated as follows:

000 Mechanized poultry transfer
001 Methane generation for Waste Utilization
002 Improved turkey harvesting techniques
003 Evaluation of packaging equipment needs in poultry processing plants
004 Evaluation of critical energy factors in the poultry industry

Task 000

The conceptual study of the catching, hauling and unloading of broilers was initiated during this period. It was decided to work closely with Wilson & Co. as they are currently conducting a study to initiate their own system instead of using contract haulers. Contact was made with Purdue Farms as they are installing an automated TransAir system in their new North Carolina plant. We will visit in a month or so when in operation. Foster Farms in California was contacted as they are the largest producer but they use the manual method and know of no other system than the TransAir. They requested information on any system we develop. A meeting has been scheduled with University of Georgia personnel during the next period to discuss developments in this area.

Task 001

The methane digester has been completely installed in Cumming, Georgia. The electrical systems have been connected and checked out. Filling with water, depth probe calibration, leak checking and complete system checks will continue through the next period.

Valves have been installed in the 5-gallon laboratory digesters and system checkout is underway. These will be recharged next period.

Task 002

Mechanical design of the turkey loading device is proceeding. The structural design is essentially complete with work starting on the hydraulic system design.

Task 003

Design work on the solar collector was finalized and work on the heat distribution system is continuing. This effort with construction is scheduled to begin the next period.

Task 004

This task work is complete.

Respectfully Submitted,

James F. Lowry

R. L. Yobs
Laboratory Director

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

March 3, 1976

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737 for Period 1 February 1976 through 29 February 1976

Dear Mr. Jordan:

This summarizes activities on Project A-1737 with tasks designated as follows:

000 Mechanized poultry transfer
001 Methane generation for Waste Utilization
002 Improved turkey harvesting techniques
003 Evaluation of packaging equipment needs in poultry processing plants
004 Evaluation of critical energy factors in the poultry industry

Task 000

Discussions of catching, hauling and unloading of broilers were held with several processors and cost data for the operation were accumulated. Several site visits to innovative operations are scheduled for next period.

Task 001

Leak checking and calibration of the various instrumentation systems have been completed on the 10,000 gallon digestor in Cumming, Georgia. Initial charging with poultry manure and the incubation time are anticipated for the next period.

The 5 gallon laboratory digestors have been completely checked out and charging with manure is anticipated next period.

Task 002

Mechanical design of the turkey loading device is proceeding.

Task 003

Engineering drawings of the solar/broiler house application were completed and checked with Wilson and Company. Construction is anticipated next period.

Task 004

This task work is complete.

Final report preparation for project A-1737 was initiated and will continue through the next period.

Respectfully submitted,

J F. Lowry

R. L. Yobs
Laboratory Director

ljb

A-1737

ENGINEERING EXPERIMENT STATION

GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

April 9, 1976

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737 for Period 1 March 1976 through 31 March 1976

Dear Mr. Jordan:

This summarizes activities on Project A-1737 with tasks designated as follows:

000 Mechanized poultry transfer
001 Methane generation for Waste Utilization
002 Improved turkey harvesting techniques
003 Evaluation of packaging equipment needs in poultry processing plants
004 Evaluation of critical energy factors in the poultry industry

Task 000

Site visits to several operations to view new techniques of catching, hauling and unloading broilers were postponed because of a disease outbreak in the industry. These will be rescheduled as soon as feasible. Contact was made with Dr. Bob Brown of the School of Agricultural Engineering UGA and information has been obtained on a system developed by their group. This is currently being evaluated.

Task 002

The need for particular expertise has held up the design work on the turkey loading device and a no additional cost extension until June 30, 1976 has been obtained. A meeting with the turkey producers is set for next month to discuss the final details of the loader.

Task 003

Construction has begun on the solar collector/storage facility. Grading has been completed although delayed by the rain and installation of the frames and stone will begin next period.

Task 004

This task work is complete.

The preparation of the final report rough draft is complete and has been submitted to typing. Review will begin early next period.

Respectfully submitted

J. F. Lowry

R. L. Yobs
Laboratory Director

bsw

A-1737

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

May 6, 1976

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737 for Period 1 April 1976 through 30 April 1976

Dear Mr. Jordan:

All efforts under Project A-1737 have been completed except for the turkey loading project which you have agreed to extend until June 30, 1976. The final report for A-1737 has been completed and issued and hopefully you have received your copy by this time.

Relative to the study of improved turkey harvesting techniques, a meeting of the Georgia Turkey Farmers Advisory Committee was held at the University of Georgia to discuss the increasing complexity and cost of an automated loader with a telescoping top end and pre-loader. The group agreed that the system was becoming too complex and expensive to be utilized by the Georgia industry when operable. Therefore, it was decided for the research study to concentrate on a preloading conveyor to work with existing loaders.

We agreed to take this approach because it is believed the Jerome loader currently available alleviates the loading conditions the study was originally intended to eliminate. It is now up to the turkey growers to take advantage of the available system to reduce the breast blisters and tiring labor.

The proposed work will consist of obtaining a commercially available conveyor and determining if it can be utilized to better load turkeys onto the main loading conveyor. This work will continue through the next period.

Respectfully submitted,

James F. Lowry
Program Manager

R. L. Yobs, Laboratory Director

A-1737

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

June 11, 1975

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan, Jr.

Subject: Monthly Progress Summary Letter for EES/GIT Project A-1737 for the period 1 May 1975 to 1 June 1975

Gentlemen:

This monthly letter report summarizes activities on project A-1737 directed to:

(1) Development of poultry processing equipment

(2) Utilization of poultry wastes, and

(3) Energy conservation.

During this period activities on (1) above have been directed to critical analysis of the hock cutting machine—transfer conveyor—rotating arm system. This analysis has shown that the system is sensitive to timing errors at the hock machine—transfer conveyor interface and that variations in drop time ($\pm$ 40% of nominal drop interval) will severely limit operation of the system. Consequently, attention has been directed to development of means to remove birds from the hock cutting machine under positive control. The present course of action includes development of a container-conveyor to hold birds as they move through the hock machine and to transport them from the hock machine to the eviscerating conveyor line. Birds will be subsequently rehung by positively removing them from the containers with the eviscerating line shackles. Verbal briefings of industry representatives concerning operation of this approach have been held and design is proceeding on the several mechanisms required.

Activities on (2) above have been directed to an intensive analysis of systems requirements for a full-scale pilot waste utilization plant located on-site at a poultry layer operation. This systems study includes considerations of the digestor-tank size, ancillary equipment including electrical generation and gas distribution, and utilization of sludge. This systems study is continuing and is intended to provide the basis for construction of a full-scale pilot unit (approximately 1-10 tons wet layer manure capacity) during the next fiscal year.

A new task, analysis of critical energy needs in the poultry industry, was initiated during the last period. Under this effort energy use in the poultry industry is being surveyed and critical energy uses are being identified. Conservation techniques (both short term and longer range) are being identified through site visits to hatcheries, feedmills, broiler houses, egg processors and poultry processors. Evaluation of several processes was begun to determine cost-effective energy-saving devices and procedures.

During the next period research will continue in each of the three areas described above. Design will continue on the containerized transport and rehang system. Systems studies supporting design of a pilot methane generator-waste utilization unit will be continued and the study of energy intensive processes and alternatives will be continued. Also during the next period two additional tasks, assessment of additional mechanization needs in processing plants and design of turkey harvesting equipment, will begin. During the next period verbal briefings will be held with representatives of the Georgia Poultry Federation and the Department of Agriculture in which detailed progress will be described.

Respectfully submitted,

J. L. Birchfield
Project Director

ct

A-1737

Final Report
Project A-1737

Poultry Waste Utilization
Turkey Loader Design
Solar Energy Application to Heating a Broiler House
Poultry Industry Energy Audit

by

J. E. Dawkins, J. F. Lowry,
A. D. Poulin, J. M. Wood

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

April 1976

Final Report
Project A-1737

Poultry Waste Utilization
Turkey Loader Design
Solar Energy Application to Heating a Broiler House
Poultry Industry Energy Audit

by

J. E. Dawkins, J. F. Lowry,
A. D. Poulin, J. M. Wood

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

April 1976

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance and continued support of members of the Georgia Poultry Industry without whose direct efforts this work would not have been accomplished. In particular to Mr. Bob Smith and Mr. George Bailey for allowing the methane digestor to be located on their layer facility, to Mr. Lamarr Hicks for allowing the solar heating system to be installed in his broiler farm, and to all the owners and managers who provided energy data for a comprehensive survey of the industries' energy usage.

TABLE OF CONTENTS

TABLE OF FIGURES

SUMMARY

Research into technical improvement of the Georgia Poultry industry is a continuing program at the Engineering Experiment Station at Georgia Tech. This report covers efforts expended under Research Project A-1737 from April 15, 1975 through April 14, 1976. As several of the projects are long term programs, work is continuing under Research Project A-1771. Each of these projects is discussed in this report.

Work under Research Project A-1737 was directed to four primary tasks:

1) Laboratory and pilot scale studies of the utilization of poultry manure to generate synthetic natural gas (methane) and an effluent of increased value.

2) Study and design of a turkey loading system to improve loading efficiency and reduce bird damage.

3) Application of solar energy to broiler house heating.

4) Audit of energy use in the Georgia poultry industry.

The poultry waste utilization effort continued with construction of a 10,000 gallon pilot facility in Cumming, Georgia. This facility is in its initial loading stage preparing for culture incubation. Laboratory studies indicated that hyperbaric operation increased methane production. Hydrogen injection was shown not to be a feasible operating method.

A survey of the turkey industry was completed and a basic design for an acceptable loader was found. Modifications utilizing this basic design are in progress.

A solar collection and storage system for heating a broiler house was designed and is currently under construction.

An audit of industry energy use was completed and it was found that over 3.4 trillion British thermal units of energy, at a cost of $13.5 million, was consumed in 1974 in all segments of the industry.

INTRODUCTION

The activities included in Research Project A-1737 were conducted by the Engineering Experiment Station at Georgia Tech for the Georgia Department of Agriculture under a continuing program for the technical improvement of the Georgia poultry industry. Research Project A-1737 covers the efforts expended from April 15, 1975 through April 14, 1976. These research efforts were conducted under the general direction of the Georgia Poultry Federation and the project direction and results were monitored by the Tech Poultry Advisory Committee. This committee is made up of industry leaders from various segments of the industry. A list of the members of this committee is included in Appendix A-1.

Research Project A-1737 contained four primary tasks:

1) Laboratory and pilot scale studies of the utilization of poultry manure to generate synthetic natural gas (methane) and an effluent of increased value.

2) Study and design of a turkey loading system to improve loading efficiency and reduce bird damage.

3) Application of solar energy to broiler house heating.

4) Audit of energy use in the Georgia poultry industry.

The poultry waste utilization research was a continuation of efforts begun during Research Project A-1659 and the research will continue under Research Project A-1771. The purpose of the program is to study the anaerobic digestion of poultry waste with the goal of optimizing the quality and quantity of both the generated synthetic natural gas and the liquid and solid effluent. As a result of the laboratory work conducted under Research Project A-1659, it was determined that a pilot facility located on a layer farm was required to acquire meaningful data that could be applied to actual full scale operating conditions. A 10,000 gallon anaerobic digestor system was designed and constructed on the Bob Smith Poultry Farm near Cumming, Georgia. This system includes a manure holding tank, mixing tank, digestor, temperature control system, pressure control system and materials handling system. Associated instrumentation to measure and analyze gas composition and flow rate and to monitor digestor ph, oxygen reduction potential, and temperatures was installed. Automatic data recording equipment was incorporated into the design. This system has been checked out operationally and is being loaded with manure and water feedstock. Culture incubation will begin when loading is complete and continuous operation is anticipated in the Spring of 1976.

Concurrent with the pilot scale digestor design, additional laboratory studies were conducted in five gallon batch digestors to assist in determining the optimum operating conditions for pilot scale operations. Five digestor systems were constructed for simultaneous operations; however, two were rendered useless because of mechanical air leaks that developed during the incubation period. Preliminary qualitative evaluations from the remaining digestors indicate that the gas production rate and composition can be appreciably improved when operating the digestor at a slightly negative gauge pressure and that hydrogen injected into the digestor head space prior to initial startup considerably reduces the incubation period and the probability of subsequent digestor poisoning. The laboratory system has been modified and is being readied for additional loading rate studies and investigations into phenomena experienced in the pilot facility.

As a result of the study conducted on turkey harvesting techniques under Research Project A-1533 in fiscal year 1974, further research was conducted into the design of a turkey loading system for Georgia turkey growers. This effort was expended with the goal of designing a system that would:

1) Reduce the laborious task of loading 20-30 pound turkeys,

2) Reduce costs associated with the premium pay required by the laborious work,

3) Reduce bird damage caused by rough handling, and

4) Modify operational requirements for more efficient loading.

To accomplish these goals a survey of the industry was made and a large turkey producer was located who had developed a loader for his use which satisfies the first three above goals. It was decided to modify this loading system to accompish the fourth goal. Agreement was received from the Georgia Turkey Farmers Association that the Association would have such a system constructed when the engineering drawings were complete. The existing loader design was modified by substituting a telescoping capability to allow for movement toward and away from the coops without moving the loader itself and by adding a preloader for assisting the turkeys into the loader.

The detailed design work was not completed as scheduled on the turkey loader because of the complexity of the problem and the lack of existing loader drawings. This phase of Research Project A-1737 has been extended through June 30, 1976 at no additional cost. It is anticipated that a complete set of engineering drawings will be prepared by this date.

Propane and natural gas shortages and rapidly rising energy costs created industry interest in auxiliary heating systems for broiler houses and as a result it was decided to demonstrate the application of solar energy to the heating of a broiler growout house. A local grower volunteered the use of a 20,000 bird house. Subsequently an integrated collector/rock storage system 208 feet wide by 16 feet tall and 8 inches thick was designed for installation adjacent to the facility. The design included a 6 inch thick rock bed which will be covered with a double layer of Monsanto 602 ultraviolet treated polyethylene. The collector will be connected to the house by submerged concrete conduit and heat allowed to flow into the house by means of natural convection. Installation of this system has begun and operating data will be acquired under Research Project A-1771.

In order to better understand how energy was used in the Georgia poultry industry an audit of the 1974 industry wide consumption was conducted. Significant samples of actual energy-use were obtained from broiler growers, broiler processors, feed mills, hatcheries and egg processors. These data were then analyzed and characterized as to type of fuel, industry segment and type of process in which the fuel was used. It was determined the Georgia industry used over 3.4 trillion British thermal units of energy in 1974 at a cost of more than $13.5 million. This energy was primarily in the form of natural gas, electricity, fuel oil and propane with 40% being used by processors and 32% by the broiler growers. An important result of this work was the initiation of an energy conservation research program which is being conducted under Research Project A-1771.

I. POULTRY WASTE UTILIZATION

One of the continuing problems associated with the poultry industry is the disposal of manure generated by the birds during their growing and/or laying period. Sources from the literature give a wide range of manure production, but a reasonable range appears to be between 0.2 and 0.3 pounds per bird each day. With current poultry population figures and the above waste production estimate, approximately 11,500 to 14,000 ton of fresh manure are produced in Georgia each day. Generally, this manure is disposed of by spreading upon pastures, gardens, etc. and allowing for natural decomposition and leaching into the soil. In this form it is used as a soil supplement and, at best, it is a low return operation for the grower. In most cases it is a cost type operation.

During Research Project A-1659, initial laboratory experiments were conducted to study the feasibility of utilizing poultry manure as the feedstock for an anaerobic digestor. This digestor, using bacteriological fermentation, would in turn produce a synthetic natural gas (methane), carbon dioxide, solid effluent and liquid effluent. These batch experiments conducted in laboratory beakers indicated that the concept was technically feasible. Analysis based on production rates experienced in the laboratory indicated that such a system could be economically feasible depending on the value of the solid and liquid effluent.

As a result of this work it was concluded that a double faceted approach was required to optimize the gas and effluent production in a continuous digestor. Initially laboratory batch studies in five (5) gallon size digestors. would be initiated to study the effect of pressure, head gas, temperature and solids loading on gas production rates and composition. Secondly, a pilot facility of practical size would be constructed to determine the effects of continuous-flow operation on gas production, gas quality and effluent quality. Also in the pilot unit materials handling problems that could be expected in any practical situation along with their effects on the economics of such an operation could be evaluated. During Research Project A-1737 these two approaches were initiated and are currently in operation as an on-going portion of the waste utilization research under Research Project A-1771.

Laboratory Studies

The laboratory experiments were designed to produce an information matrix with which to optimize the pilot facility operation. It was anticipated that this laboratory work would allow several parameters to be investigated simultaneously and those proven unacceptable could be discarded prior to pilot facility operation. This approach would allow for more efficient use of the pilot facility and allow for a faster generation of results. To accomplish these goals five 5-gallon batch reactors were built. Each consisted of one 5-gallon glass bottle connected to laboratory designed and constructed gas monitor and control devices. Each reactor was fitted with stainless steel diaphram pumps to recirculate the reactor gas or to provide a vacuum for hyperbaric or reduced pressure operation. Each digestor was immersed in thermostatically controlled water baths to maintain a given set-point temperature.

These five digestors were then charged with a homogenous feedstock of 35 percent layer manure and 65 percent water by volume and were operated under the following conditions:

1) Baseline or control digestor maintained in the mesophilic (98°F) temperature mode
2) Mesophilic (98°F) temperature mode with hydrogen injection

3) Thermophilic (135°F) temperature mode
4) Thermophilic (135°F) temperature mode with hydrogen injection
5) Mesophilic (98°F) temperature mode operated with the digestor pressure maintained at less than atmospheric pressure (hyperbaric)

It was planned that the digestors would be operated over a 30-60 day period with the gas production and composition measured continuously by the gas monitoring devices and an automatically sampling gas chromatograph. However, massive leaks in purchased components of the gas control and monitoring devices rendered both of the thermophilic digestors totally useless. The mesophilic digestors were able to be operated, but the results were strictly qualitative.

The mesophilic control digestor required a 6 week incubation period and achieved a maximum total gas rate of 0.2 liters per hour per gallon of feedstock. The maximum methane composition achieved was 70 percent of the total gas produced. The remainder was carbon dioxide. This resulted in a maximum methane production rate of 0.14 liters per hour per gallon of feedstock.

The mesophilic reactor with hydrogen injection required essentially the same incubation time. Initially there occured an increase in methane production, however, where the hydrogen flow was terminated the gas rate coincided with that of the mesophilic control. This dictates the conclusion that the bacteria were feeding from the hydrogen and converting it to methane instead of acting as a catalyst for the consumption of the feedstock. However, it was observed that with hydrogen the bacteria culture appeared tolerant to 6-7% air level which would have destroyed cultures under normal conditions.

As anticipated the hyperbarically operated reactor performed better than the other mesophilic digestors. The maximum methane rate obtained was 0.25 liters of methane per hour per gallon of feedstock. This is almost twice the amount generated from the control digestor.

As a result of this laboratory work it was concluded that the performance obtained with hydrogen injection along with the cost of hydrogen renders this mode of operation impractical. Therefore, no further work will be done in this area. The pilot facility will be initially operated in the mesophilic temperature mode with a pressure of one pound per square inch below atmosphere being maintained in the head space gas.

After this initial experiment was completed the reactors were completely dismantled and reassembled with modified and leak proof components. Removal of the hydrogen injection systems greatly simplified the mechanical construction and removed a major source of leaks. Additionally, modifications have been made in the temperature control system to improve the reliability and response time. These reactors have now been completely leak checked and prepared for further experiments.

Loading experiments are currently underway with five different concentrations. Concentrations of 10, 20, 30, 40 and 50 percent raw layer manure mixed with water by volume have been loaded into the digestors to measure the effect of loading on gas rate production and composition. These are currently in their incubation period and the digestors are functioning well. Results of this experiment and others to support the pilot facility operation will be continued under Research Project A-1771.

Pilot Facility

Development of the pilot facility was based on the concept of providing a digestor and associated equipment of sufficient size to allow for the economic and chemical/microbiological evaluation of the process in a practical operating situation. Heretofore, efforts have been expended by investigators on laboratory sized models and these have not produced the data required to determine the economic feasibility of such a process. As an example, little is known about hauling, storing and pumping of manure slurry so that the design and reliability of the holding, mixing and pumping system results in an unknown cost factor in the economics of operation. These and other material handling parameters along with research of biological conversion within the digestor itself under field conditions were the impetus to the design, construction and operation of the pilot facility.

The digestor as designed and constructed is not representative of a commercial facility in that it is highly instrumented to acquire necessary research data and is capable of various modes of operation. Instrumentation includes the equipment to continuously monitor digestor oxygen reduction potential, digestor ph at the top and bottom of the tank, several digestor temperatures, digestor head space pressure, gas production rate and gas composition. The system is capable of maintaining mesophylic (98°F) and thermophylic (135°F) operations, agitation or no agitation of the digestor contents, varying retention times, varying infeed quantities on a timed basis, both volumewise and timewise, varying head space pressure from one (1) pound per square inch below atmosphere to one (1) pound per square inch above atmosphere, and has the capability of hydrogen injection if desired. This design allows for more extensive research into gas production and effluent optimization while concurrently providing materials handling and economic information.

The pilot facility digestor system consists of a manure holding tank, mixing tank and digestor with associated plumbing, valving and instrumentation. Figure 1 shows a general layout of the system. Operationally, raw manure from an adjacent layer facility is transported by truck to the holding tank. Daily approximately 0.75 tons of raw manure is conveyed by screw conveyor to the mixing tank where it is mixed to the proper concentration with preheated water. By means of a hot water heat exchanger the mixing tank is maintained at the preselected digestor temperature so that the digestor heating system only has to maintain temperature and there is no thermal shock with feedstock injection into the digestor. A material handling schematic of the facility is shown in Figure 2.

For economics of operation and to test the viability of such a process, the overflow water from the layer feeders is being used as the feedstock diluent. Analysis indicated there are no antibiotics in this water that are not already present in the liquid portion of the manure which is approximately 80 percent water. It is planned during subsequent phases of this research to evaluate the possibility of using the liquid effluent from the digestor as the principal feedstock diluent.

A discription and the design philosophy for each component is as follows:

Holding Tank--The holding tank is an eight foot diameter, mild steel tank, eight feet in height with a cone bottom to an eight inch discharge spout. Mounted on top is a closure and receiver for the manure from the transport truck. Details of the hold tank are shown in Figure 3 and the complete system is shown in Figure 4.

A manure holding tank is required in the system because layer houses are normally cleaned weekly and a week's supply of feedstock must be acquired at this time. For mesophylic digestor operation, a 20-day retention time was assumed which required 400 gallons of feedstock each day. This in turn requires about 200 gallons of raw manure; therefore, the hold tank was required to hold 1400 gallons and was designed to have a 2200 gallon total capacity. For thermophilic operation, which can have as short a retention time as 3 days, the hold tank will have to be filled more often than weekly and this has been arranged with the facility operator. A picture of the holding tank is shown in Figure 5.

Mix Tank--The mix tank is a surplus stainless steel tank 6 feet in diameter and 6 feet tall. Mounted on the top of the tank is a 3-horsepower, single phase motor driving a mixer for feedstock mixing during the filling process. A hot water heat exchanger is mounted inside the tank for preheating the feedstock to the digestor temperature before injecting into the digestor. Details of the mix tank are shown in Figures 4 and 5. The size of the mix tank was dictated by initial fill requirements, retention time flexibility and tank availability. The mix tank holds approximately 1000 gallons of feedstock so that only one fill cycle per day will be required for mesophylic operation, however, as retention time is reduced to 3 days with thermophilic operation, the capability exists to vary either the quantity per fill or fill frequency.

Digestor--The digestor is a 10 foot diameter mild steel tank 22.5 feet tall with a conical bottom. This tank has an approximate capacity of 10,000 gallons and it is planned to operate with 8000 gallons of feedstock and the remainder for gas head space. Design details of the digestor are shown in Figures 5 and 6.

The digestor is equipped with ph and oxygen reduction potential probes 4 feet and 12 feet from the top surface of the feedstock to allow for ph determination at the two levels of digestion. The feedstock level is maintained by means of level control probes that control the amount of effluent pumped out of the digestor and the amount of feedstock pumped into the digestor each cycle. Temperature of the digestor is maintained by heating tapes and insulation placed on the outer surface. There are two taps on the side of the digestor for removing feedstock samples for composition studies. The digestor has the capability of recirculating the feedstock from the bottom of the digestor to the top and can reinject the generated gas into the feedstock. Both can be used for agitation purposes if desired.

As presently configured for this phase of work, the resulting gas, liquid effluent and solid effluent will be measured for rates of production and thoroughly analyzed for composition. Then the gas will be released to atmosphere or flared. The solid and liquid effluent will be dispersed about a pasture by discharging through a flexible hose. The lack of utilization of the generated output was dictated by the lack of funds for gas and effluent handling equipment and by the fact that the quantity and characteristics of the output were not well defined. It was anticipated that these characteristics would be defined during this current phase of work so that development of gas and effluent utilization equipment could be accomplished during subsequent research.

As of this reporting date the digestor is in the process of being charged with feedstock so that it may begin its initial culture incubation period. The raw manure is approximately 80 percent water and it is being mixed in a ratio of 40 percent manure and 60 percent water. This results in an eight (8) percent solid loadings for the initial charge. When the digestor is fully loaded with 8000 gallons of mixture and the feedstock is homogeneous, then samples will be analyzed to determine an accurate solids loading.

During this initial loading, ten pounds of cattle manure was introduced into the digestor as seed material for starting the microbacteriological culture. During the incubation period, anticipated to be 30-40 days, the seed culture will grow and multiply to fill the digestor volume using the feedstock as food. After the incubation is complete and the gas production rate has stabilized, daily removal of effluent and introduction of fresh feedstock will begin. The amount to be removed and introduced will depend on the digestion time, which has yet to be determined from effluent and gas analysis.

Several materials handling problems have developed with the system as designed. The raw manure which is transported by screw conveyor from the holding tank to the mix tank displayed a tendency to bridge during the transporting process at the beginning of the operation. A shaker system was envisioned for the holding tank, however, with subsequent loads of manure this has not been a problem. Although this may have been a start-up problem it will be monitored closely during subsequent operation as to its tendancy to occur intermittantly.

A problem of more significant portent for the successful operation of the digestor has been the settling of foreign matter such as feather stalks, small stones, undigested corn kernels, sand, etc. into the cone of the tank. These have displayed a tendancy to plug the outlet of the digestor and prevent the removal of the effluent. To date this has occured over two to four day time spans and it is anticipated that the tendency to plug the digestor will be reduced when regular, daily withdrawal and insertion is begun.

II. TURKEY LOADING SYSTEM

During a study of turkey harvesting techniques conducted under Research Project A-1533, several possible designs were suggested. Generally, the methods suggested were so sophisticated and expensive that they have not been adopted by the industry. Therefore, this study was undertaken to design an economically feasible turkey loading system that would:

1) Reduce the laborious task of loading 20-30 pound turkeys,
2) Reduce costs associated with the premium pay required by the laborious work,
3) Reduce bird damage caused by rough handling, and
4) Modify operational requirements for more efficient loading.

To accomplish this a thorough survey of the turkey industry was made to determine the most advanced systems presently available. It quickly became apparent that the Georgia turkey industry, at 2-3 million birds per year, is very small relative to the total industry, which produces in excess of 130 million birds per year. Indeed, the Georgia industry is so small that there is no processing plant within the state. Obviously each operator is small and is not able to make large capital investments in specialized equipment or to train personnel in specialized operational procedures. Because of this it was believed to be advantageous to survey large growers outside of the state to determine their loading methods. Several visits were made to large growers in North Carolina and Wisconsin to develop an understanding of the turkey loading problems and possible solutions.

Generally the turkey industry is much like the broiler industry in that each grower is an independent element in the overall industry and sells his turkeys along with many other growers to a central processing facility. During processing at this facility each turkey is inspected by representatives of the United States Department of Agriculture (USDA) and graded according to quality. The grading experience of the Georgia producers that ship to processing plants in North Carolina and Virginia has been about 85 percent Grade A whereas the general industry level has been 90-95 percent. This results in considerable loss of revenue to the growers. Studies have shown that most of the down grading results from bruises on the breast and wings of the birds which generally occur during the loading process.

The loading procedure exclusively employed by Georgia growers is to herd a small group of turkeys into a temporary chute that leads to a conveyor which raises the birds to the coop level on the back of a truck. These trucks have a specially constructed body with 15.5 inch high coops. The coops have hinged sides that open upward to allow entry of the birds into the coop. As the turkeys reach the top of the conveyor a worker grasps the turkey which weights from 16 to 30 pounds by the neck and body feathers and throws it through the open door into the coop. This is repeated until the coop is full. Then the conveyor is hydraulically raised or lowered to the next coop and the procedure repeated until all coops in two vertical layers are full. There is no practical way to remove the 3 foot gap between the loader and the truck since the loader is stationary relative to the truck and the spacing is determined by the truck driver. Truck fore and aft movement is required to fill coops in different vertical rows and the truck must be turned around to fill both sides.

From studying films of this loading procedure it became evident that the majority of breast and wing bruises to the birds were occurring during the entry into the coops. As the loader becomes slightly fatigued or if his grip on the turkey is tenuous it is very easy for the bird to drop slightly and catch its breast on the bottom edge of the coop opening or to catch a wing on the edge of the coop. To help alleviate this problem, growers already restrict loaders to working about 15 minutes at a time and extra incentive pay equivalent to $8 per hour is paid, but these measures have resulted in little reduction in animal bruising during loading.

During the survey of operations within the industry, contact was made with Jerome Foods in Barron, Wisconsin. This firm loads about 3 million turkeys each year and because of this volume, has developed some specialized equipment and procedures for the loading operation. The Jerome turkey loader sits on a carriage with street-rated wheels and tires which allow it to be towed along a commercial thoroughfare from flock to flock. In operation, these wheels allow the loader to move toward the coop and eliminate the gap between the loader and coop. The loader itself is composed of a main conveyor belt and a top conveyor belt running at a slightly higher speed. This configuration forces the turkey's head down and forces it to sit quietly on the bottom belt. As the bird approaches the top of the conveyor it is ejected from the loader directly into the coop where a one-handed shove by the loader makes sure the bird moves to the rear of the coop. As the bird is never lifted, there is very little fatigue to the job of loading and Jerome regularly attains gradings of 95 percent Grade A in the processing plant.

The two conveyor belts are completely enclosed and separated from side to side by a vertical splitter plate so that two coops can be loaded simultaneously. Operationally, the loader can be raised and lowered hydraulically and can move forward and aft on its carriage to eliminate the space between the loader and coop. Once the loader is in place one worker on each side at the bottom of the loader introduces the proper number of turkeys into the loader to fill one coop, then stops. When both sides are filled the loader is backed away from the truck and raised or lowered to the next higher or lower coop. To move from row to row the truck is repositioned and it must be turned around to load all coops on the truck. Pictures of the Jerome loader are shown in Figure 7 .

Throughout the industry this was the most efficient loading system found during the survey, and it was decided to design a new loading system for the Georgia industry using the Jerome loader as the basis for the design. Approval was obtained from Jerome Foods to proceed with this design work under the condition that Jerome Foods be provided a final set of drawings for its own purpose. Also, an existing set of preliminary sketches of the loader were obtained. It was agreed by members of the Georgia Turkey Farmers Association Advisory Committee to furnish Jerome Foods with a set of completed drawings and the committee agreed to have such a system built when the design drawings are complete.

The design concept for the improved turkey loader included the dual belt conveyor system as utilized in the Jerome loader; however, two modifications were included to improve the loading operation. A telescoping conveyor system was incorporated into the top end of the loader to allow for movement away from and toward the truck without moving the support carriage. This resulted in a much safer operation from the worker viewpoint and gave to the operator a more sensitive control over the position of the loader as well as eliminating wheel ruts.

Secondly, a preloading conveyor was to be designed into the system to properly position and direct the turkeys into the main conveyor without requiring a strenuous effort by the operator. The preloader is composed of a horizontal conveyor located a few inches from the ground. A wooden, low angle ramp leads from the ground to the horizontal conveyor. This conveyor meets with the main conveyor and is designed to move the turkeys from the field area to the main conveyor. Additionally, vertical baffles on each side of the horizontal conveyor converge on the main conveyor to force the turkeys into a single file. A splitter plate is used to separate the two sides of the preloader and to direct the properly positioned turkeys into each side of the main conveyor. Operationally an operator at the lower end of the conveyor would start the preloading conveyor and introduce turkeys into the main conveyor until the proper number for each coop had passed. Then he would stop the preloader and wait until the top of the loader was repositioned at the next set of coops and then repeat the operation. It is anticipated that eventually this operation will be automated by counting the birds automatically and stopping the preloader when the prescribed number have passed. Then the top operator could reset the automatic counter after repositioning the loader. However, this feature will not be incorporated until the design is proven.

Because of the design complexity and the lack of detail design drawings on the existing Jerome turkey loader, the engineering drawings were not completed by the expiration date of Research Project A-1737 and a no-cost extension was granted to complete the work. It is anticipated that the engineering drawings will be completed by June 30, 1976.

III. APPLICATION OF SOLAR ENERGY TO BROILER HOUSE HEATING

Because of the rapidly escalating propane costs and at the request of the Tech Advisory Committee, The Georgia Poultry Federation and several interested firms in the industry, it was decided in December 1975 to design and install a solar heating system on an operating broiler growout house. This effort was undertaken with the knowledge and consent of the Georgia Department of Agriculture.

After preliminary analysis it was decided to approach the problem with the goal of designing a relatively inexpensive solar heating system that was simple enough in design to be installed and operated by a grower without specific engineering knowledge. It was felt that if successful this type of system had the greatest probability of industry acceptance and could be made progressively more sophisticated if required.

Wilson & Company in Cumming, Georgia, was approached to cooperate in this effort. They readily agreed to participate in the experiment by providing a progressive broiler growout operator willing to make modifications to his facility to accommodate the solar heating system. It was also agreed that Wilson & Company would provide, within reasonable limits, the materials necessary to construct the solar collector and storage system.

The broiler growout house selected has an east-west roof line and on the south side is a gently sloping hillside. For experimentation purposes it was decided to place the collector on the surface of the sloping hillside. The broiler house is 32 feet wide by 345 feet long and accommodates 20,000 to 25,000 broilers per brood. It has closed sidewalls and ventilation is provided by both timer and thermostatically controlled fans. The building has one inch of ceiling insulation.

In evaluating the design requirements of the solar system, an attempt was made to determine the heating load of the broiler house. However, analysis of the environmental conditions required by the broilers imposed highly variable ventilation and heating requirements on the heating system so that defining a static heat load was impractical. Generally, temperature is maintained at approximately 90°F during the first week of the brood, then reduced about 5°F each week until 70°F is reached. Temperature is then maintained at 70°F for the remaining 3 weeks of the growout period. The ventilation requirements of the animals which create the need for fresh air to be introduced into the house is more complicated than the temperature requirements. This is a function of the age of the broilers, the outside temperature, the solar radiation and the ammonia buildup from floor litter, and results in a requirement to exchange large volumes of air.

To furnish this ventilation, time controlled fans operate for a predetermined duration each ten minutes and thermostatically controlled fans operate when the inside temperature rises to a predetermined level. These fans pull in outside air to replenish the oxygen supply in the house and to limit the temperature to a preset maximum. All of these variables made the calculation of a heat load impractical since the load varies continuously. Therefore, it was decided to design a system of practical size for the experiment and to determine from operations the savings in fuel that could be realized.

A 16 foot by 208 foot collector was designed with the capability of providing 1.2 million British Thermal Units of energy on an average day. Since the grower was using split house brooding where the chickens are maintained in the center portion of the house during the first 4 weeks, it was decided to introduce the heated air from the collector only into the center portion of the house. This appeared reasonable because approximately 80 percent of the year round heating requirements occur during the first four weeks of each brood and the size of the collector should produce about 75 percent of the total anticipated load based on the average of 40 gallons of propane per 1000 birds.

Several systems using water and air collectors were evaluated with the relatively simple air collector with integrated rock storage being selected for use. This system is being constructed by leveling the hillside surface to a constant 30° slope angle, installing 6 mil thick polyethelene as a vapor barrier and filling it to a 6 inch depth with rock. Two different sizes of rock, 1 1/2" and 4", are to be tested. A double layer of Monsanto 602 plastic film will be placed over a wooden frame and will create a sealed air space to reduce convective and conductive losses from the rock storage system. The bottom layer of film will be in physical contact and supported by the rocks in the storage unit. An attempt will be made to maintain the spacing between the two layers of clear plastic film at 2 inches. The top surface of the rocks are to be painted black with a flat black paint applied by a compressed air spray painting system. Detailed design drawings of the solar heating system are shown in Figure 8 .

The collector is to be connected to the center section of the broiler house by means of 8 inch cement pipes. These pipes extend through the black plastic into the rock storage system and run underground to the broiler house and underneath the dirt floor of the house. Each pipe will exit the floor vertically near an existing support post as protection during the litter cleanup operation. Each of these standpipes will extend vertically about 18 inches above the dirt floor.

Initially, the system calls for the free flow of warm air from the collector/storage system into the broiler house through the 8 inch cement pipes. No pumps, fans or valves are included in the system to force warm air into the house. This is possible because of the elevation of the broiler house relative to the collector and the physical property that warm air rises above cold air. It is recognized that other applications may need forced systems depending on the location of the collector relative to the house.

During the first experimental operation scheduled for May 1976, it is anticipated that the cement pipes will be uncapped in the broiler house after the sun has initially heated the rock storage. This will allow warm air to rise through the collector bed, through the pipes and into the house. As additional air is pulled into the collector bed it too will be warmed before flowing into the house. This activity will continue as long as the collector is warmer than the house temperature. The amount of warm air entering the house will be controlled by changing the openings in the cement pipes extending up from the broiler house floor. Additionally, particularly in cool weather, the intake baffles of the broiler house will have their openings reduced so that the fresh outside air will be pulled in through the collector and preheated before entering the house.

As previously stated, construction of the solar system is in progress and experimental operations are scheduled to begin in May of 1976. These will continue as needed through the summer and the 1976-77 winter period, and the final results will be delivered in succeeding reports.

IV. AUDIT OF ENERGY USE IN THE GEORGIA POULTRY INDUSTRY

Currently the fastest growing drain on profits in the poultry industry is the rapidly increasing cost of energy. With the decreasing supply of domestic oil and natural gas that was highlighted by the oil embargo during the winter of 1973-1974, the cost of energy to the poultry industry has increased dramatically over the last two years. Even worse, in some locations certain fuels have become scarce or curtailed to the point of being unavailable. Natural gas curtailment has actually happened to the poultry industry in the Gainesville, Georgia, area. To date most growers and processors have been able to continue operations by switching to alternative fuels, such as fuel oil or propane, but these fuels cost 2.5 to 4.5 times more than natural gas. In the face of this situation it was decided to conduct an audit of the energy used in the poultry industry in order to better understand how energy is used and in what forms and amounts it is utilized, and to determine areas where initial energy conservation research is needed.

Scope and Methodology

To develop a complete characterization of the industry, it was decided to divide the industry into five segments:

1) Egg Processing
2) Broiler Processing
3) Feed Mill
4) Hatchery
5) Broiler Producer

It was also decided to exclude transportation costs from this study and only consider the actual processing costs, and all resulting information reflects this decision.

Based on these decisions it was then required to visit with and acquire actual energy use data from a significant sample of companies within each segment of the industry. Actual 1974 energy use data were acquired from firms representing 9 percent of the egg processing market, 46 percent of the broiler processing market, 14 percent of the feed market, 35 percent of the hatchery market and 1 percent of the broiler production market. Information acquired during each visit included monthly energy consumption figures derived from actual fuel receipts and a complete description of how each form of energy was utilized in the production process. An energy audit form was developed for this purpose and is included in Appendix A-2. These data were then compiled and extrapolated to provide data for the entire Georgia poultry industry.

Results

Analysis of the audit data indicated the industry used over 3.4 trillion British thermal units (BTU's) of energy in 1974 at a cost in excess of $13.5 million. This energy was utilized in the form of electricity 24.8%, natural gas 41.2%, fuel oil 3.1% and propane 30.9%. These quantities are as follows:

1974 POULTRY INDUSTRY ENERGY USE*

Electricity	248,739,742 Kilowatts	848.7 Billion BTU's	24.8%
Natural Gas	1,409,300,000 1000 FT^3	1409.3 Billion BTU's	41.2%
Fuel Oil	757,042 Gallons	107.0 Billion BTU's	3.1%
Propane	11,468,478 Gallons	1055.0 Billion BTU's	30.9%
Total Energy Use		3420.0 Billion BTU's	100.0%

*Not including transportaion

These forms of energy were utilized in several processes common to each segment of the industry. The broiler processor uses natural gas or its alternate, fuel oil, to fire a steam boiler to heat the scald tank and water for the picker. Natural gas is also used in singers and for space heating. Electricity is utilized to operate storage and ice making compressors and to operate a multitude of motors on the assembly line.

The egg processor utilizes natural gas to heat water in the egg washer and for space heating. Electricity is used to operate motors on the egg packaging line.

The feed mill uses electricity primarily to operate motors for grinding, loading and mixing feeds. Natural gas, fuel oil and propane are generally used to drive a steam boiler which in turn keeps the fat tanks warm and controls the moisture and dries pellets in the pelletizer.

Incubators and hatchers are self-contained units in the hatchery and are powered solely by electricity. Natural gas or fuel oil is utilized to heat water in the tray washers and for space heating.

Natural gas and propane are the primary fuels for the broiler producer and either fuel is utilized for space heating by local brooders that maintain the area temperature at a preset level. Electricity is also used for feeder and watering motors and for lighting.

From the audit, the energy use by each industry was found to be as follows:

1974 POULTRY INDUSTRY ENERGY USE BY SEGMENTS*

Segment	Energy Use BTU's	BTU/Unit	Cost/Unit	Percent
Broiler Processor	1372 Billion	3,320/Bird	1.10¢/Bird	40
Egg Processor	104 Billion	226/Doz.	0.15¢/Doz.	3
Feed Mill	702 Billion	330,000/Ton	$1.15/Ton	21
Hatchery	128 Billion	310/Chick	0.17¢/Chick	4
Broiler Producer	1096 Billion	2,660/Bird	1.24¢/Bird	32
Total	3420 Billion			100%

*Not including transportation

As expected, the broiler processor is the major user of energy since the processor makes the greatest change in the final product over the shortest period of time. However, the broiler producer consumes considerable energy because of the duration in which he handles the broilers. Extrapolating the broiler producer data to the entire United States industry indicated 122 million gallons of propane was used in 1974, which is in agreement with data published be the United States Department of Agriculture.

Assuming typical or average cost factors of 3¢ per kilowatt hour for electricity, 90¢ per 1000 cubic feet for natural gas, 35¢ per gallon for fuel oil and 40¢ per gallon for propane, it was determined that over $13.5 million was spent for energy by the Georgia Poultry Industry in 1974. These costs are listed by types of energy as follows:

1974 POULTRY INDUSTRY COSTS*

	Unit Cost	$/Million BTU's	BTU's	Cost
Electricity	$0.03/KWH	$8.80	848.7 Billion	$ 7,468,560
Natural Gas	$0.90/1000 Ft^3	$0.90	1409.3 Billion	1,268,370
Fuel Oil	$0.35/Gallon	$2.44	107.0 Billion	261,080
Propane	$0.40/Gallon	$4.35	1055.0 Billion	4,589,250
	Total		3420.0 Billion	$13,587,260

Weighted Average Cost Per Million BTU's = $3.97

*Not including Transportation

Also listed is the cost per million BTU's of energy which indicates that electricity is almost ten times more expensive than natural gas and fuel oil is 2.5 times more expensive. This explains the increased energy cost when natural gas is unavailable. For the Georgia industry, the weighted average cost per million BTU's is $3.97 and compares to $0.90 per million for natural gas alone. Therefore, it can be concluded that any change from natural gas to an alternate fossil fuel will result in an increase in cost.

Analysis of the segment data shown above indicates the cost per unit of output for each segment of the industry. This was derived by dividing the total units produced by each segment in 1974 into the weighted cost of energy for that segment. Total units for each segment were derived from available production figures relative to producing 413 million broilers. These calculations resulted in the following unit costs:

Broiler Processor	1.10¢/Broiler
Egg Processor	0.15¢/Dozen
Feed Mill	$1.15/Ton
Hatchery	0.17¢/Chick
Broiler Producer	1.24¢/Bird

Comparison of these data with several companies in each segment of the industry indicates a large variation in individual cost depending on management, type of equipment and geographical location. Therefore, these cost data should be applied with caution to a particular operation.

Responses to discussion with plant managers, general managers and owners indicated that the most critical energy factor in the industry today is the availability of natural gas. Supplies have already been restricted or curtailed and as the cost analysis indicates, fuel oil or propane is from 2.5 to 4.5 times as expensive. Therefore, it was considered vital to evaluate alternative fuel supplies to replace natural gas in case of further restrictions.

Other forms of commercially available basic energy to be considered included coal, nuclear, hydroelectric, wind and geothermal. Nuclear, hydroelectric and geothermal were dismissed because they are not physically or practically available to the individual element within the industry. Research into wind power indicated that the average wind velocity in Georgia is insufficient to maintain any reasonable flow of energy and this form was dismissed from consideration. The remaining form to be considered was coal.

Coal is commercially available and on a historic basis coal has been used to heat broiler houses, hatcheries and to provide hot water for broiler-processor scald tanks. Therefore, a thorough evaluation was conducted to determine the advisability of using coal as an alternative fuel for natural gas.

Inquiries were made of several coal fired boiler manufacturers and it was learned that the coal fired boiler industry reoriented itself over the last 30 years to the very large boilers used by electric utilities. Therefore, the small 200-500 horsepower boiler required for the poultry industry is not generally available. However, several observations relative to the cost of coal fired systems were obtained from recognized authorities on coal systems and are as follows:

1) Equipment cost of a coal fired boiler system is about 10 times that of a comparable natural gas fired system,

2) Equipment life of a coal fired boiler system is approximately one-half that of a comparable natural gas system and

3) Operation and maintenance requires at least one man at all times.

Based on these observations and assuming the boiler load of a typical processing plant, breakeven coal prices as compared to various natural gas prices were computed and are presented below.

NATURAL GAS/COAL COST COMPARISON

Assumptions:	Natural Gas	Coal
Equipment Cost	\$10,000	\$100,000
Equipment Life	20 years	10 years
Operating & Maintenance	0.5 mh per day	16 mh per day
Labor Cost	\$3 per hour	\$3 per hour
Energy Use (Processing Plant)	48.8 billion BTU's	48.8 billion BTU's
Fuel Heating Value	1,000,000 BTU/1000 Ft^3	28 million BTU/ton
Fuel Requirement (Processing Plant)	48,000-thousand Ft^3	1740 tons

BREAKEVEN COSTS

NATURAL GAS	COAL
\$0.90/1000 ft^3	\$ 6.25/ton
2.10/1000 ft^3	40.00/ton
2.45/1000 ft^3	50.00/ton
2.82/1000 ft^3	60.00/ton
4.25/1000 ft^3	100.00/ton

From this analysis it can be seen that at the current cost of natural gas of \$0.90/1000 ft^3 coal would have to sell at \$6.25 per ton in order to justify changing from natural gas to coal. As coal is currently selling at about \$50 per ton then natural gas would have to rise to \$2.45/1000 ft^3 for the change over to be feasible. As indicated during the winter of 1974-1975, the price of coal tends to fluctuate with its substitute fuels such as natural gas and oil so that it is unlikely a coal fired system will become economically feasible for poultry facilities until gas and oil become much more limited in supply. However, each facility manager should periodically reevaluate the economics of the coal fired system as cost and availability change.

During visits to many facilities in all segments of the industry, it became obvious to the investigators that there was no inexpensive fuel to replace those in limited supply and increasing in price. It also became apparent that the most inexpensive and quickest way to reduce energy costs was to reduce energy consumption, particularly wasted consumption. Since most facilities were planned and constructed when energy was plentiful and inexpensive, the various processes and operations tend to be energy intensive and wasteful. Observation of these processes and operations by trained engineers resulted in several suggestions for energy savings that should be considered by all facility operators.

ENERGY CONSERVATION SUGGESTIONS

1) Use scald tank overflow as a heat source
2) Consider closed circuit steam heating of scald tanks to replace sparging
3) Use compressor exhaust as heat source
4) Consider jacketed chillers and prechilled water
5) Consider off-peak ice machine operation
6) Consider flexible, air-lock doors for coolers and freezers
7) Consider limited area brooding for young broiler chicks
8) Institute tighter operational controls on heat intensive processes
9) Off-shift operations

Demonstration of several of these suggestions will be conducted during the energy conservation program of Research Project A-1771.

Seminars

In order to disseminate the information and observations acquired during the energy audit throughout the industry, two seminars were presented and an article was published in a trade magazine. One seminar was held in Gainesville, Georgia, on October 17, 1975, and one in Tifton, Georgia, on December 12, 1975. These two meetings were attended by 42 representatives of the major factors in the industry. The greatest response was received when discussing the relative prices of various energy sources and energy conservation. This interest was verified by the audit in that the major problem for all firms surveyed was the rapidly escalating cost of energy and an appeal for aid in reducing consumption. An outline for the seminar presentation and a copy of the projected transparency material is included in Appendix A- 3 . Also, a copy of the article that appeared in BROILER INDUSTRY, a poultry industry trade publication, is included in Appendix A- 4 .

V. CONTINUING RESEARCH

Since the poultry waste utilization, turkey loading system and the application of solar energy to broiler house heating research are on-going programs, they will continue under Research Project A-1771. The energy audit program is complete and has been used as base line information and to determine primary areas of effort in an industry energy conservation program underway under Research Project A-1771.

The anticipated research objectives for each of the continuing programs are as follows:

Poultry Waste Utilization: It is anticipated that work will continue in this area over the next few years to determine the economic viability of an anaerobic digestor of poultry waste. The purpose of this work will be to determine the economic viability of locating such a system at each poultry facility within the industry. Under Research Project A-1771, that continues through August 1976, field operation of the pilot facility will continue to determine the effects of solids loading and hypobaric pressure operation on gas composition, gas production and effluent quality.

Turkey Loading System: The final design of the modified loader along with a cost estimate is scheduled to be completed under the A-1737 contract extension before June 30, 1976. This design is scheduled to be constructed under auspices of the Georgia Turkey Growers Association.

Application of Solar Energy to Broiler House Heating: Construction of the solar heating system is scheduled for completion by June 1, 1976, and data will be collected through the winter of 1976-1977. From the data will be determined the quantity of heat and percentage of total heat requirement furnished to the broiler house.

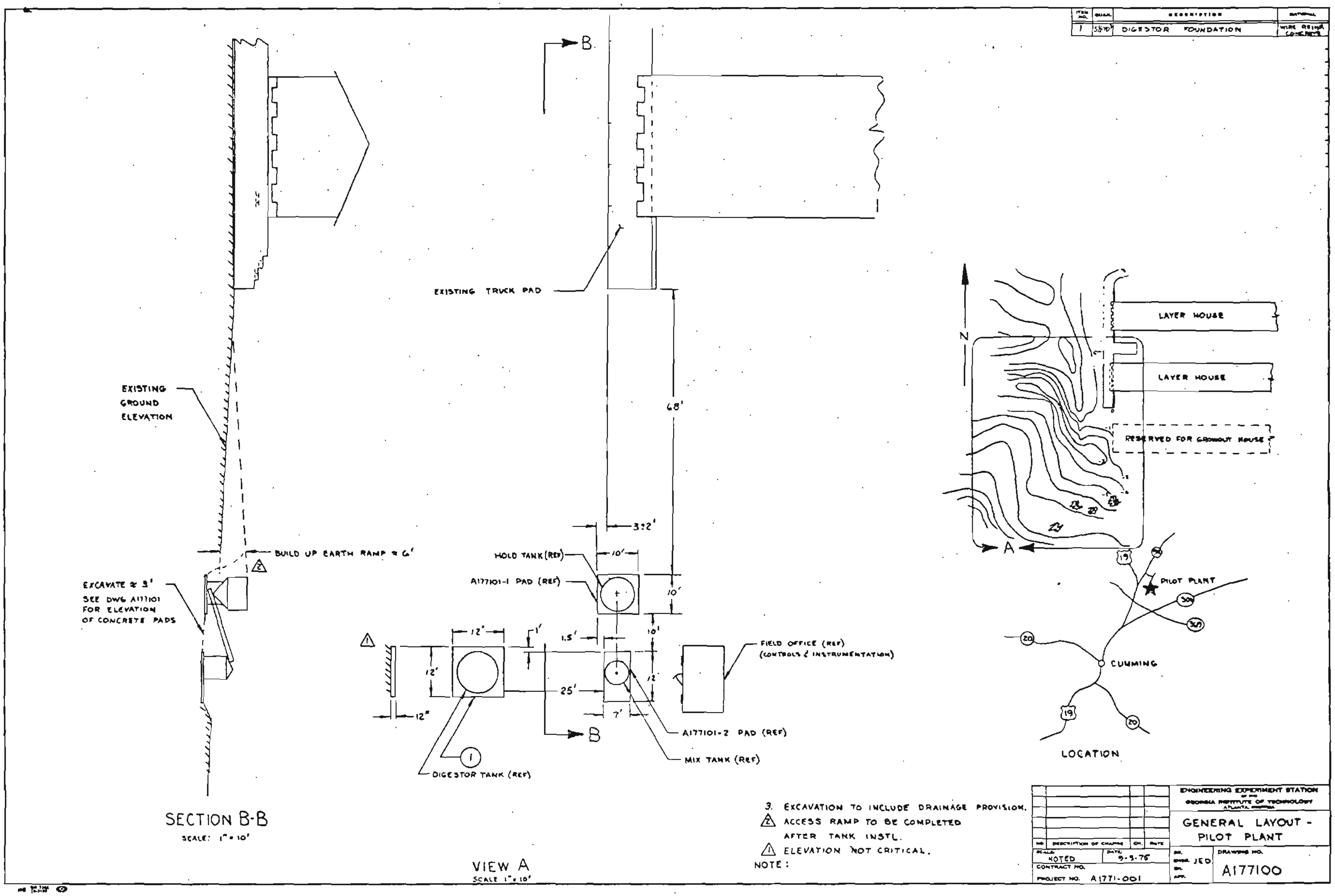


Figure 1
General Layout-Pilot System

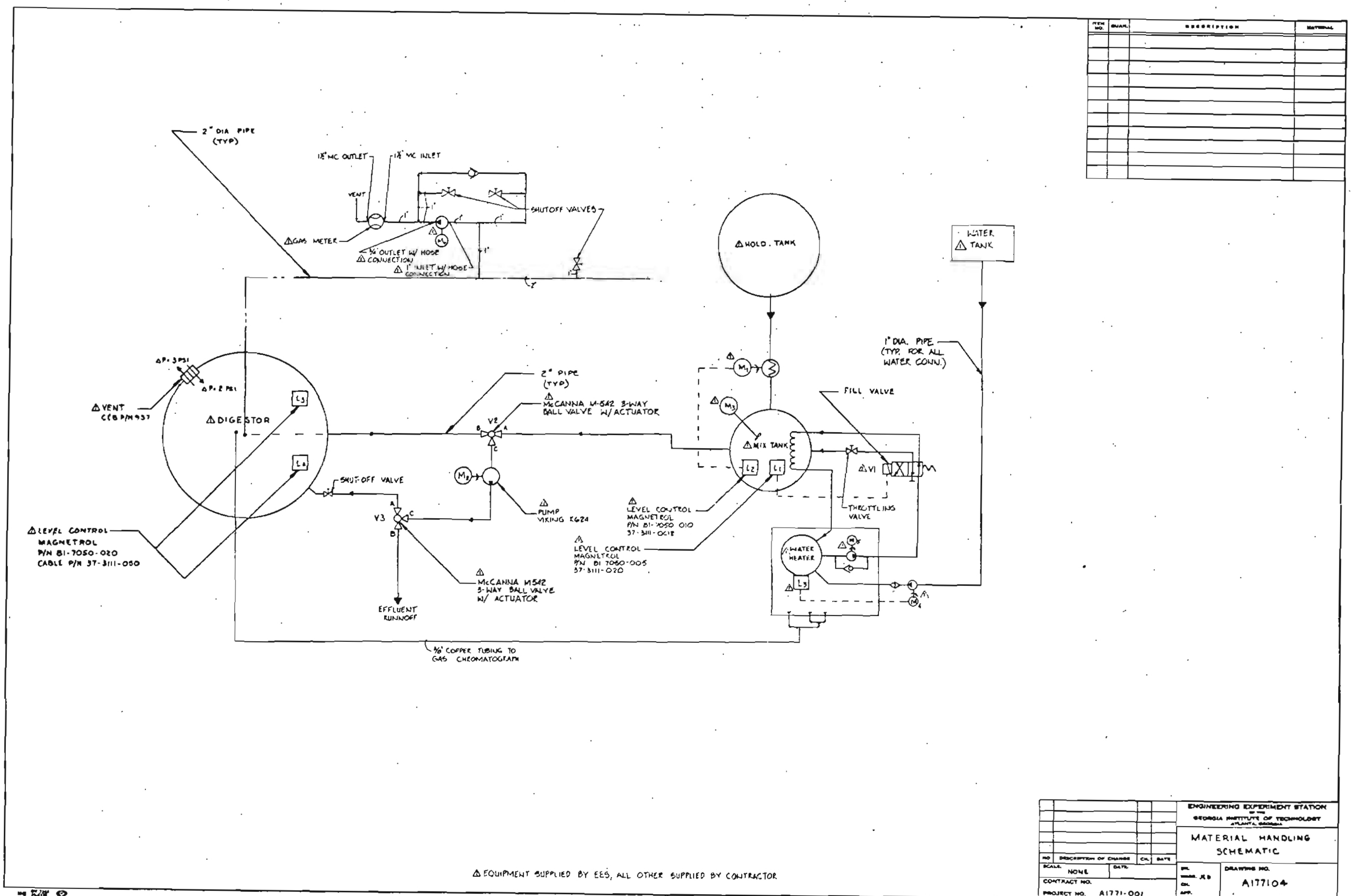


Figure 2
Material Handling Schematic

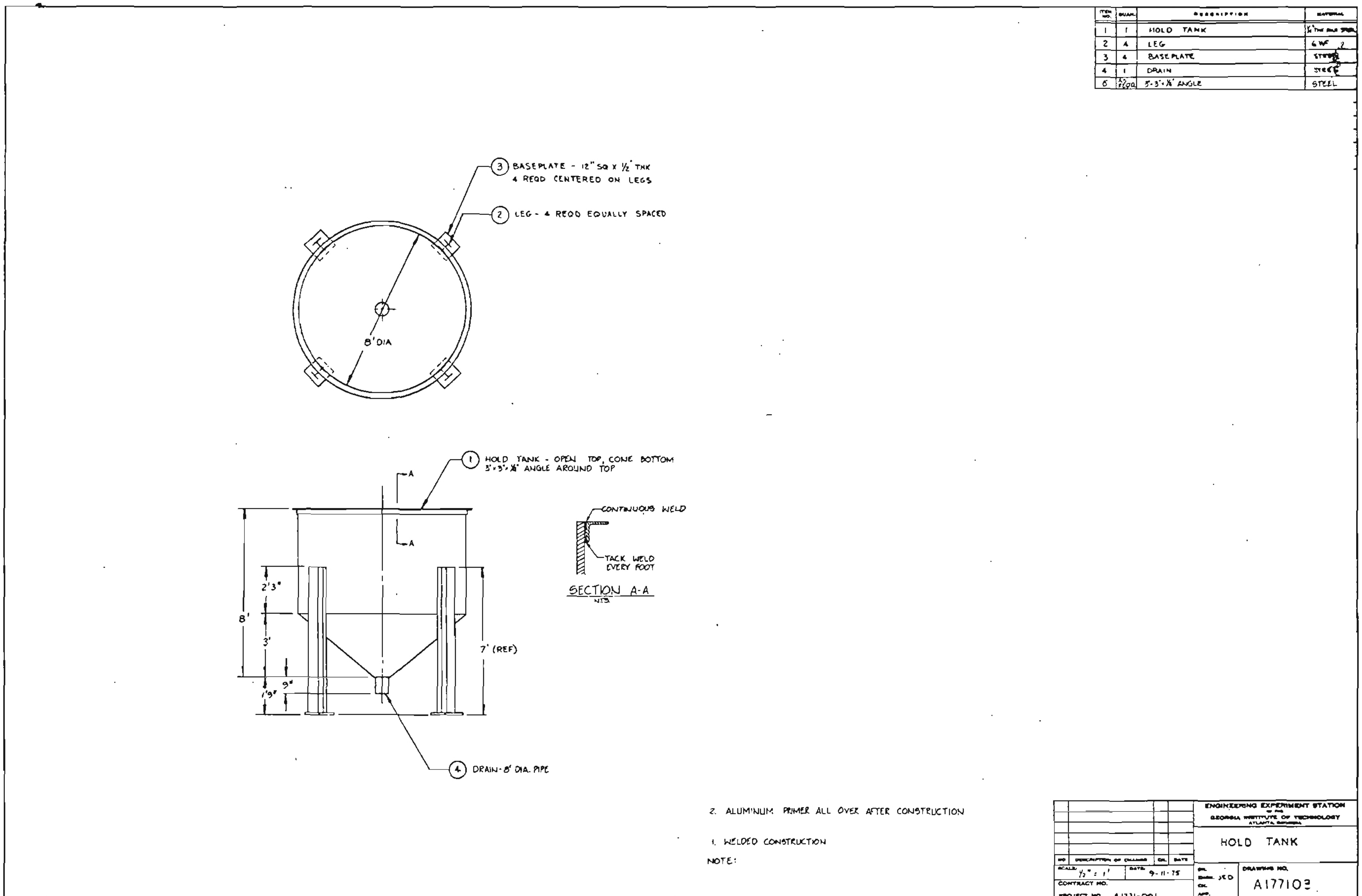


Figure 3
Holding Tank

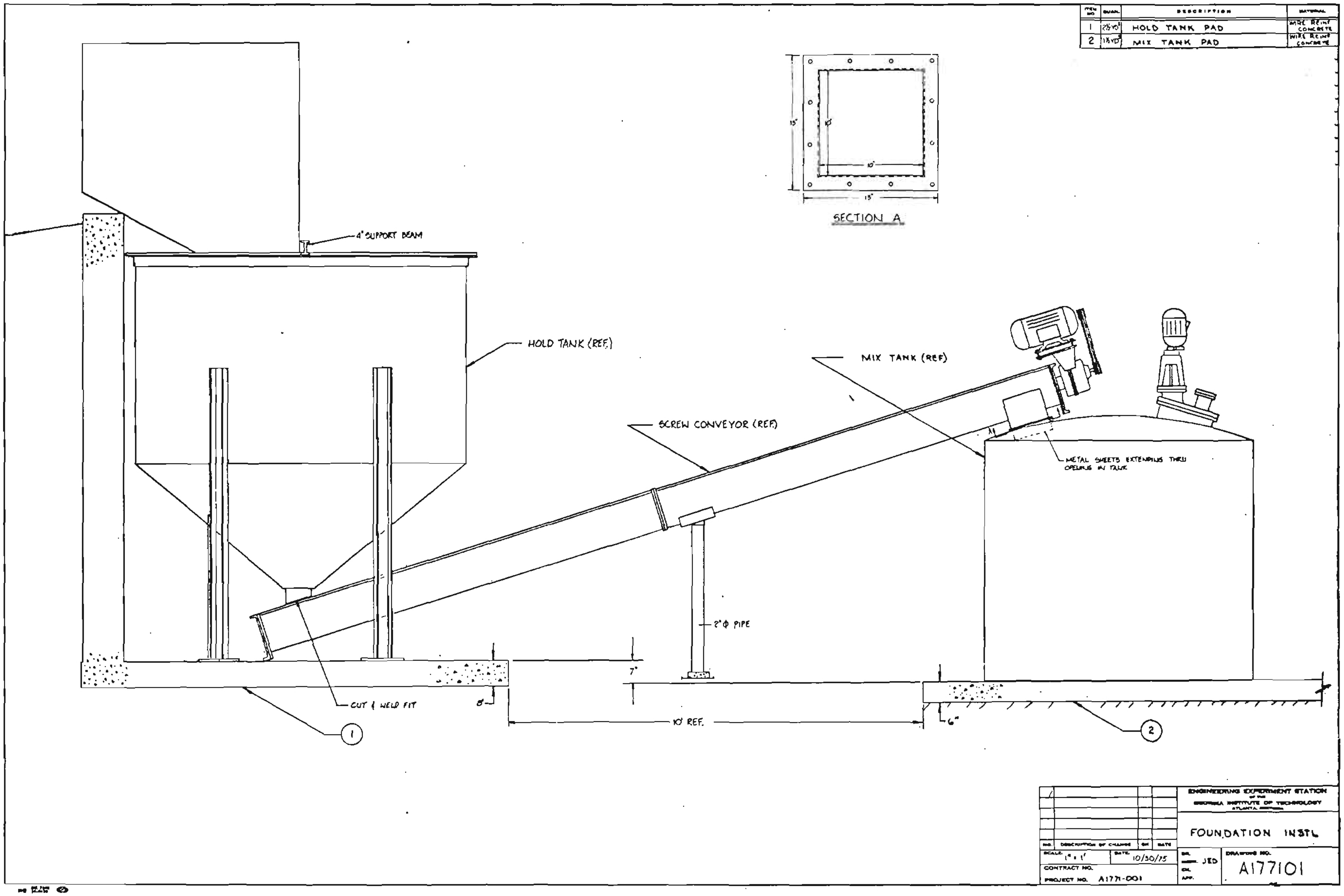
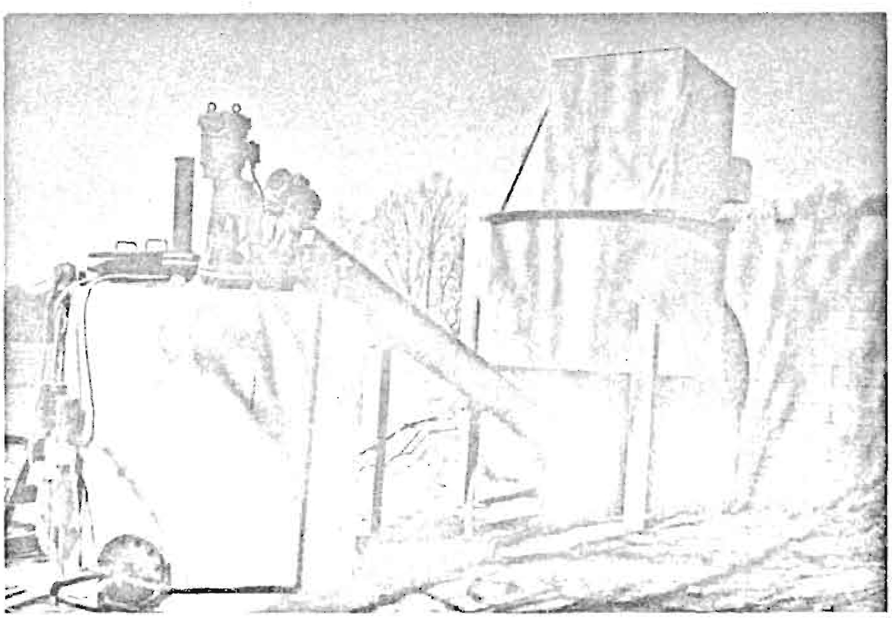


Figure 4
Holding Tank and Mixing Tank

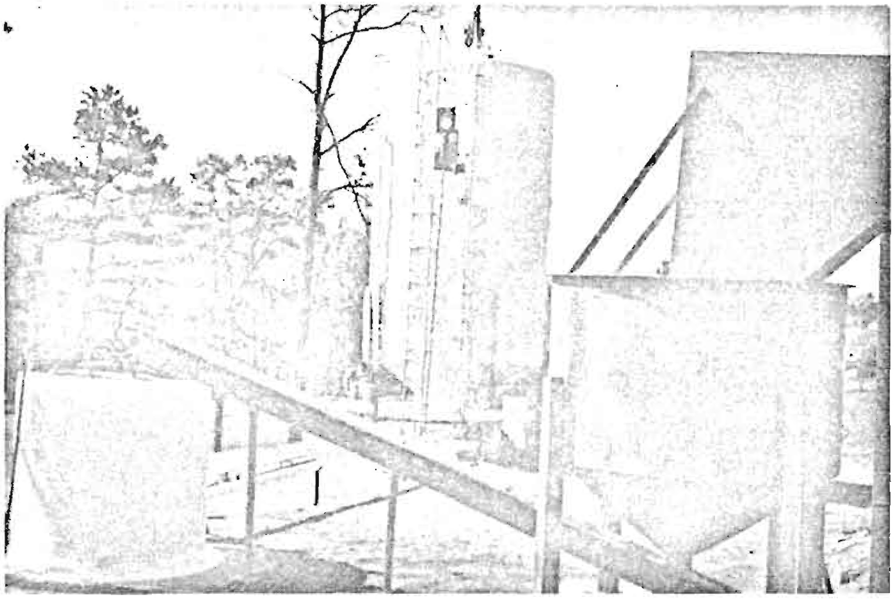
Figure 5
Anaerobic Digestor System

Overview of Anaerobic Digestor System

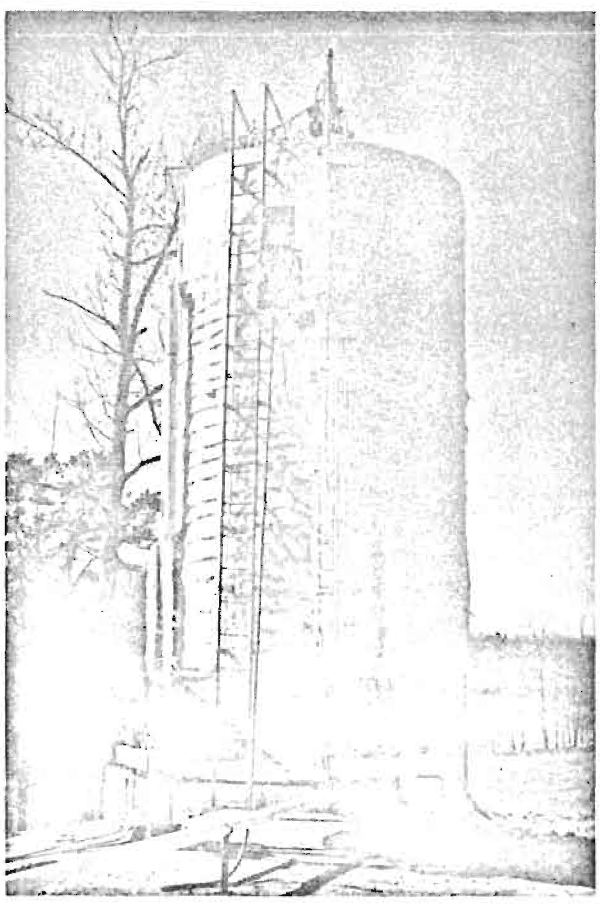


Mixing Tank (left) and Holding Tank (right)

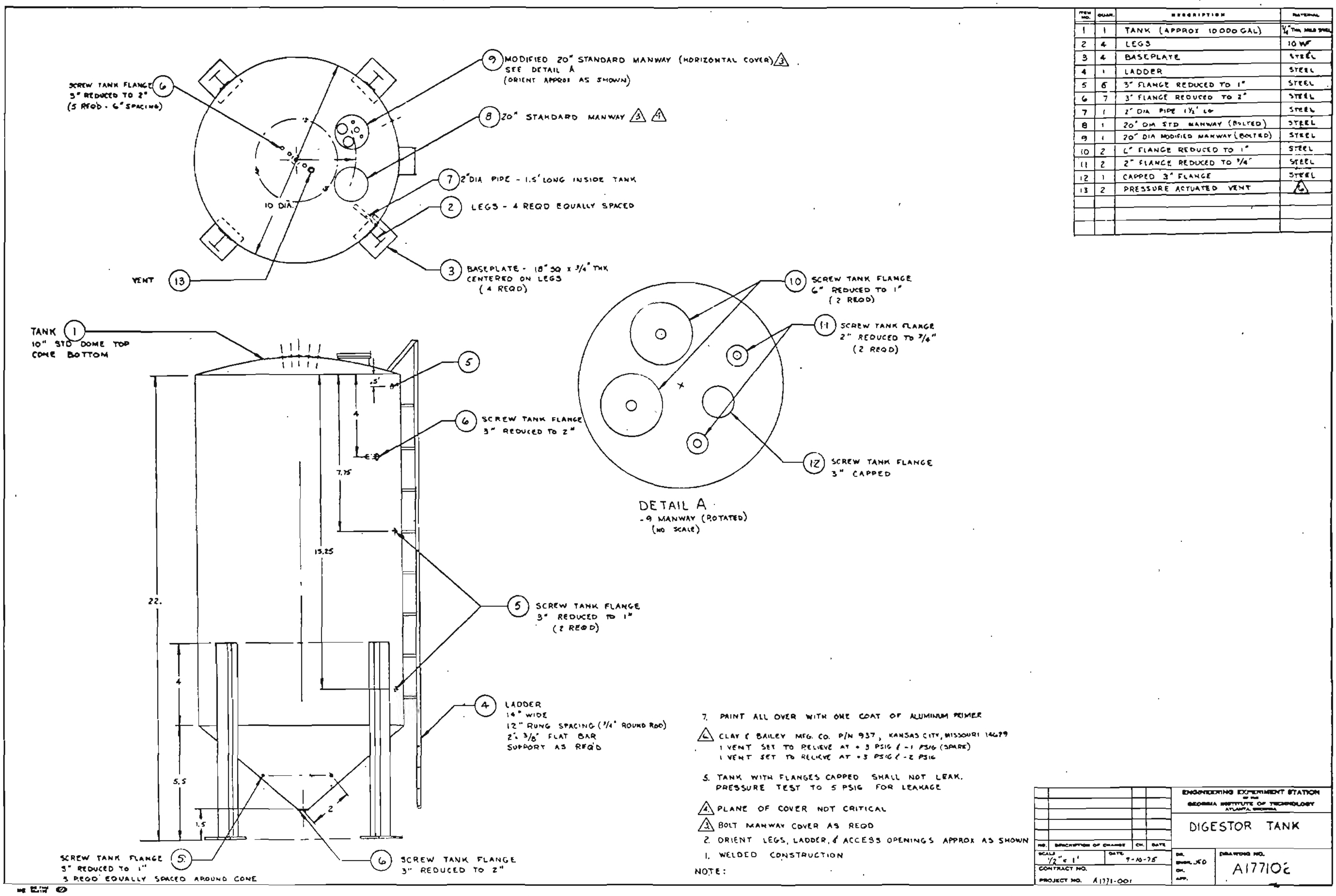
Figure 5 (Con't)



Close-up of Anaerobic Digestor System



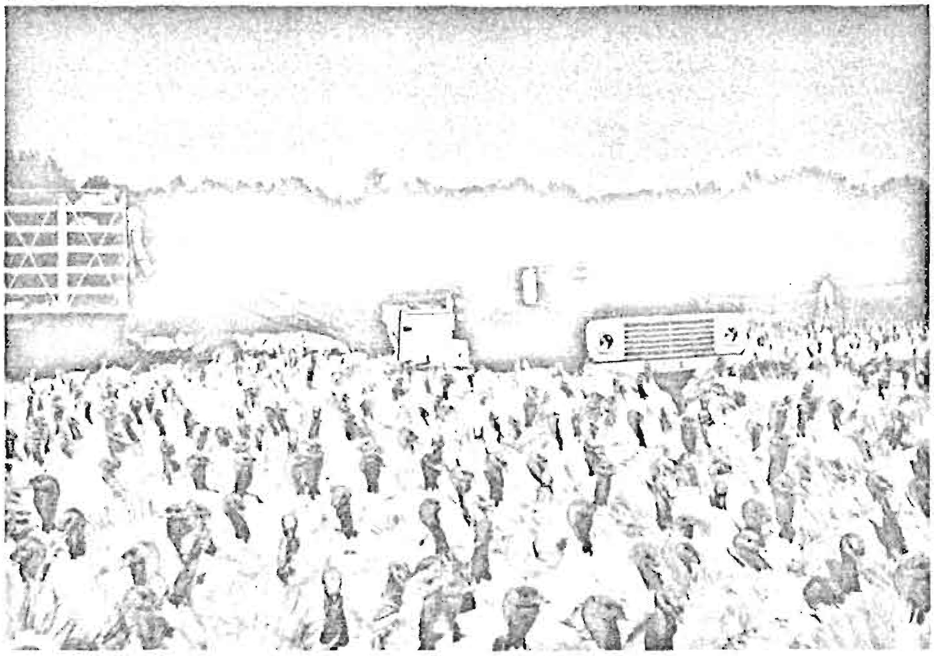
Anaerobic Digestor



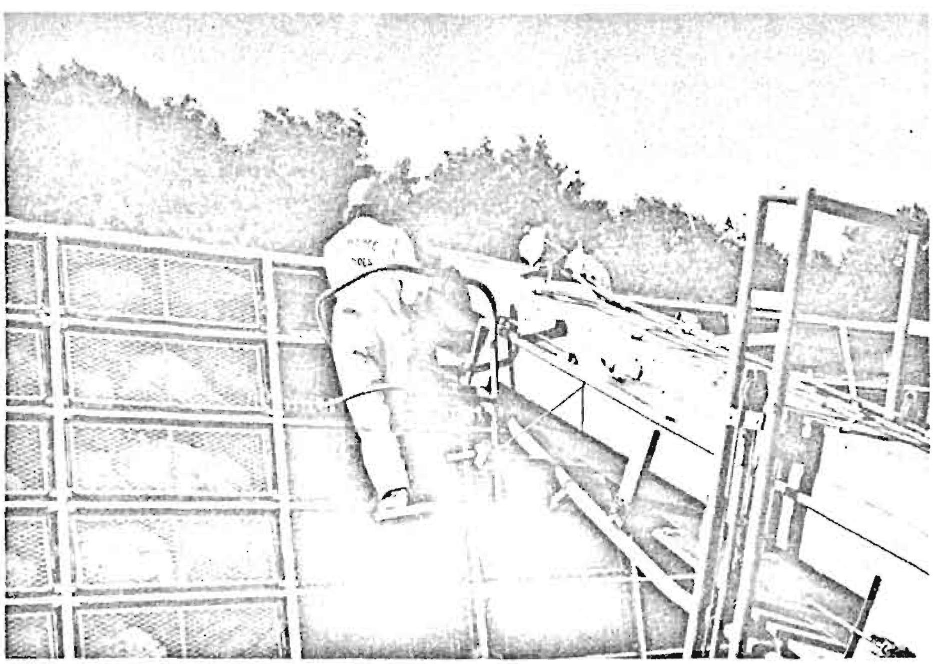
ITEM NO.	QUAN.	DESCRIPTION	MATERIAL
1	1	TANK (APPROX 10 000 GAL)	1/4" THK MILD STEEL
2	4	LEGS	10 WF
3	4	BASEPLATE	STEEL
4	1	LADDER	STEEL
5	6	3" FLANGE REDUCED TO 1"	STEEL
6	7	3" FLANGE REDUCED TO 2"	STEEL
7	1	2" DIA PIPE 1½' LG	STEEL
8	1	20" DIA STD MANWAY (BOLTED)	STEEL
9	1	20" DIA MODIFIED MANWAY (BOLTED)	STEEL
10	2	6" FLANGE REDUCED TO 1"	STEEL
11	2	2" FLANGE REDUCED TO 3/4"	STEEL
12	1	CAPPED 3" FLANGE	STEEL
13	2	PRESSURE ACTUATED VENT	6

Figure 6
Digestor Tank

Figure 7
Jerome Loader



Overall View of the Jerome Loader



Close-up View Showing the Loading Process

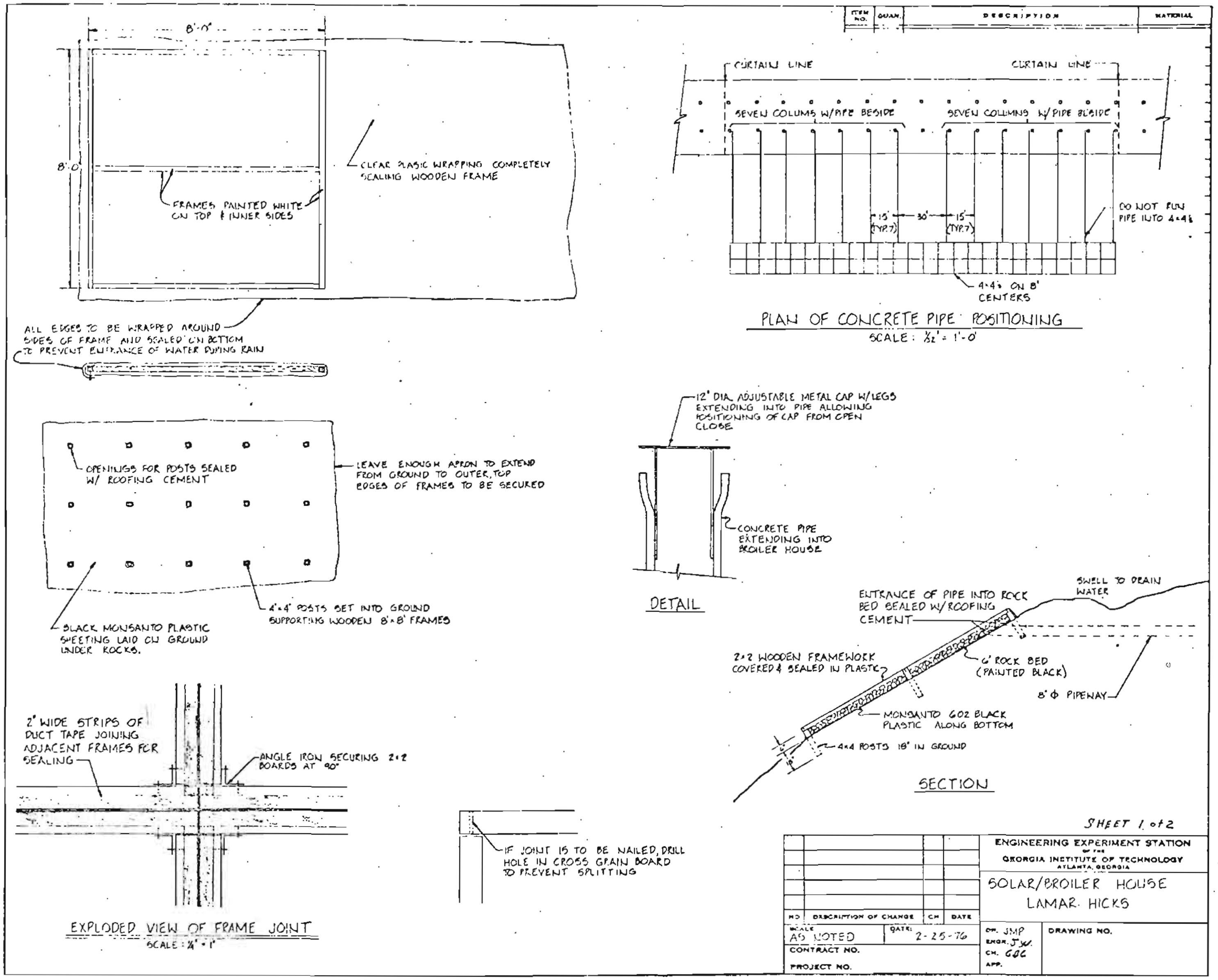
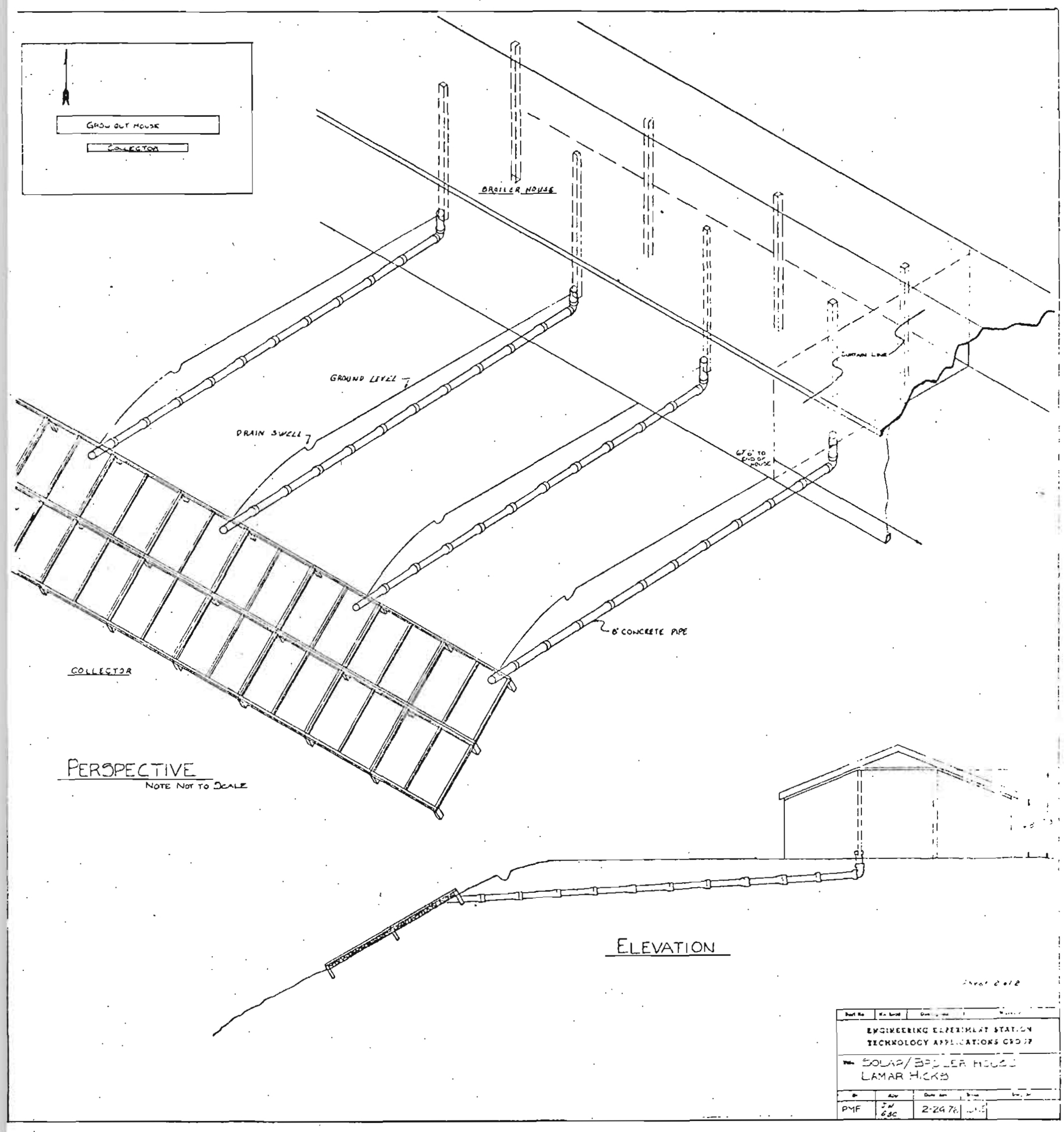


Figure 8
Solar/Broiler House

Figure 8 (Con't)



APPENDIX

APPENDIX A-1

TECH POULTRY ADVISORY COMMITTEE

Chairman:	Jack Ellerbee, Harrison Poultry, Bethlehem, GA
	Glenn Berry, Gold Kist, Athens, GA
	Tommy Folger, Marell Poultry, Murrayville, GA
	R. L. Hadden, Gold Kist, Ellijay, GA
	Charles Addison, Cagle's Poultry, Camilla, GA
	Bob Mitchell, Cagle's Poultry, Atlanta, GA
	George Deadwyler, Wilson & Co., Cumming, GA
	Dave Yeakley, Central Soya, Canton, GA
	Bill Falls, Wayne Poultry, Pendergrass, GA
	Horace Sewell, Con Agra, Dalton, GA
	Bill Adams, Cal-Maine Poultry, Metter, GA
	Norman Fries, Claxton Poultry, Claxton, GA
	George Bagley, George Bagley Milling, Cumming, GA
	Bill Owens, Owens Farms, Dahlonega, GA
	Gene Sutherland, Sutherland's Eggs, Forest Park, GA
	Chet Austin, Tip Top Poultry, Marietta, GA
	Gene Callaway, Callaway Eggs, Rayle, GA
	Ralph Cavender, C & C Farms, Claxton, GA
	Ralph Kimsey, Kimsey Eggs, Hiawassee, GA
	Perry McCranie, Bowen-McCranie Co., Tifton, GA
	Hulan Hall, Gamco, Gainesville, GA
Ex officio:	Lee Arrendale, Fieldale, Inc., Gainesville, GA
	Abit Massey, Ga. Poultry Federation, Gainesville, GA

Appendix A-2

POULTRY ENERGY PROJECT

Engineering Experiment Station

Georgia Tech

Firm Name ______________________________ Type ____________

Address ______________________________ Tel. ____________

Contact ______________________________ Position ____________

1) Type of energy used and source

Type		Source
Electricity	______	______________________________
Natural Gas	______	______________________________
Fuel Oil	______	______________________________
Propane	______	______________________________
Coal	______	______________________________
Other	______	______________________________

2) Describe uses of each type of energy

Type	Use
______________	______________________________
	______________________________
	______________________________
______________	______________________________
	______________________________
	______________________________
______________	______________________________
	______________________________
	______________________________

3) Amount of each type of energy used from January 1974 through April 1975

Type	Jan 74	Feb 74	Mar 74	April 74

Type	May 74	June 74	July 74	Aug 74

Type	Sept 74	Oct 74	Nov 74	Dec 74

Type	Jan 75	Feb 75	Mar 75	April 75

4) Energy utilizing equipment

No.	Type	Manuf	Model	SPECS

5) General description of structures

6) General description of operations

7) What are your energy problems?

8) What are your suggestions for conserving energy?

9) What alternate forms of energy are available to you?

10) Comments

Appendix A-3

BROILER INDUSTRY MAGAZINE ARTICLE

Currently the fastest growing drain on profits in the broiler industry is the rapidly increasing cost of energy; energy in the form of electricity, natural gas, fuel oil, propane and gasoline. With the decreasing supply of domestic oil and natural gas that was highlighted by the oil embargo during the winter of 1973-74 the cost of energy to all industries including the poultry industry has doubled, tripled and quadrupled over the last two years. Even worse, in some locations certain fuels have become scarce or curtailed to the point of being unavailable. This exact scenerio actually happened to the broiler processing industry in Gainesville, Georgia, one of the leading broiler centers of the country. Already processors in North Georgia, the Carolinas and Virginia have had their natural gas supplies curtailed or terminated for this winter of 1975-76. In most cases to date, processors have been able to continue operations in the face of natural gas curtailments by switching to alternative fuels such as fuel oil or propane. However, there were times when processors were on allocations that were not sufficient to meet their requirements and, in any event, they were paying from 3 to 5 times the cost for equivalent energy. As one plant manager stated "...help us, the loss of natural gas is costing us $250 a day."

In the face of this situation the Georgia Poultry Federation under the leadership of its President, Mr. Lee Arrendale of Fieldale, Inc. and Executive Secretary of Mr. Abit Massey, decided to take positive action in the area of energy. Through the Georgia General Assembly, the Poultry Federation was able to obtain state funding for a study of the energy situation in the Georgia Poultry Industry. Appropriation of funds was made for this work through the Georgia Department of Agriculture and the program was constantly monitored by an advisory committee of the Georgia Poultry Federation. Because of the technical nature of this effort, the Engineering Experiment Station at Georgia Tech, which has been designated the State Productivity Center, was commissioned to conduct an audit of the energy used in the Georgia Poultry Industry among other energy related tasks. The purpose of this audit was to determine on a statewide basis how much energy was used, in what form it was used and those processes in which it was used. As this study developed, it was expanded to include recommendations as to methods that should be considered for conserving energy in the industry.

To conduct the survey the industry was divided into five segments: egg processing, broiler processing, feed mills, hatcheries and broiler producers. A significant number of facilities in each segment was visited and observed. During these visits processes were observed and documented, throughput and capacities were recorded and actual energy use was recorded from bill and delivery tickets for the year 1974. These data were then analyzed, catagorized and extrapolated to include the entire Georgia poultry industry, which produced more than 400 million broilers and 5.5 billion eggs in 1974.

Results of this effort which excluded all transportation associated energy indicated that the Georgia poultry industry consumed over 3.4 trillion British Thermal Units (BTU's) of energy at a cost of over $13.5 million in 1974. Of this total, 40 percent was consumed by broiler processors, 32 percent by broiler producers, and 21 percent by feed mills.

Table I

1974 GEORGIA POULTRY INDUSTRY ENERGY USE*

Segment	Energy Use BTU's	Percent	BTU/unit	Cost/unit
Broiler Processor	1372 Billion	40	3320/Bird	$0.011/Bird
Broiler Producer	1096 Billion	32	2660/Bird	$0.012/Bird
Feed Mill	720 Billion	21	330,000/Ton	$1.150/Ton
Hatchery	128 Billion	4	310/Chick	$0.002/Chick
Egg Processor	104 Billion	3	226/Doz.	$0.002/Doz.
Total	3420 Billion			

*Not including transportation costs

As to the form of the energy used, 41 percent was natural gas, 31 percent propane and 25 percent electricity, with the remaining 4 percent various grades of fuel oil. Generally propane and Number 2 or Number 6 fuel oil was the substituted fuel for those facilities experiencing natural gas curtailments. Based on the following analysis it can be seen that fuel bills will jump dramatically when fuel oil or propane is substituted for natural gas.

Table 2

	Unit Cost	Cost per Million BTU's
Natural Gas	$0.90/1000 ft.^{3}	$0.90
Fuel Oil	$0.35/Gal.	$2.44
Propane	$0.40/Gal.	$4.35
Electricity	$0.30/KWH	$8.80

From this analysis, fuel oil costs about 2.5 times that of natural gas at its interstate controlled level and propane costs about 5 times natural gas so that any curtailments place a great upward pressure on energy costs for the broiler grower and processor.

With these data it was possible to calculate the cost of energy in each broiler produced in the state of Georgia in 1974. This became known as the Georgia Energy Chicken and indicates that about 2 to 3 percent of the wholesale price of a dressed broiler is directly contributable to the cost of energy throughout the production process. Indication to researchers are that this was closer to 0.5 to 0.8 of a percent just 3 years ago.

Table 3

GEORGIA ENERGY CHICKEN

	Energy	Cost*
Layer	19 Btu's	0.013¢
Hatchery	310 Btu's	0.170¢
Broiler Producer	2700 Btu's	1.240¢
Broiler Processor	3320 Btu's	1.100¢
Feed	1320 Btu's	0.460¢
Total	7669 Btu's	2.983¢

* Not including transportation costs

From Table 2 it is obvious that fuel oil or propane can be used as a substitute for natural gas in the event of curtailment. In fact, most boilers are dual controlled so that either a gas or liquid can be utilized by merely changing a control. Propane is somewhat more complicated in that an energy consuming vaporizer is needed to convert it to a gas before being introduced into the burner. Therefore, except for cost and restricted availability, these two fuels are convenient substitutes for natural gas.

In investigating potential substitutes for natural gas, the only feasible alternate fuel other than propane or fuel oil appears to be coal. However, a thorough analysis of all factors that must be considered indicate that coal must be available at \$6.25 per ton before it is economically feasible to install a coal fired boiler instead of a natural gas fired boiler, with natural gas at \$0.90 per 1000 cubic feet. The current spot market price for coal is about \$40 per ton. This occurs because of the auxilliary equipment and labor required to fuel, operate and maintain a coal system relative to a natural gas system. For comparable steam output a coal fired boiler system will generally cost 10 times that of a natural gas system, last half as long and require an order-of-magnitude more operating and maintenance labor. All this does not even include the associated environmental and pollution problems. Producing energy for a typical processing plant and making cost and labor assumptions relative to the Georgia market results in the following breakeven cost for converting from natural gas to coal as a function of the cost of natural gas:

Table 4

BREAKEVEN COSTS

Natural Gas	Coal
\$0.90/1000 ft.^{3}	\$6.25/ton
\$2.10/1000 ft.^{3}	\$40.00/ton
\$2.45/1000 ft.^{3}	\$50.00/ton
\$2.82/1000 ft.^{3}	\$60.00/ton
\$4.25/1000 ft.^{3}	\$100.00/ton

The result of this analysis is obviously that coal is not a feasible alternative until its price is reduced or natural gas becomes much more expensive.

However, it should be continually evaluated by management in the event of mass curtailments or cutoffs of natural gas in the future.

As this investigation and analysis proceeded it became clear that there are no inexpensive, readily available sources of energy to replace $0.50 per 1000 cubic feet natural gas of two years ago. All substitutes are themselves in restricted supply, expensive or both. Therefore the conclusion reached by the Engineering Experiment Station personnel is that the only short range answer for the industry is to reduce its consumption of energy. For this reason the investigators directed their efforts to analyzing energy utilizing processes with the purpose of finding mechanical and operational modifications that could reduce energy consumption without detrimentally affecting production.

In reviewing various energy intensive processes in poultry processing plants, an energy sensitive individual is immediately confronted with the large amount of heating and cooling required. As it is a physical property that heat must be removed to make something cold, it becomes a thermodynamic problem to determine methods to utilize the reject heat from the refrigeration system as a source of heat for hot water and space heating. Ammonia, which is a commonly used refrigerant in the large refrigeration units found in poultry processing plants, offers an excellent source of heat in the condensing side of the compressors because of its relatively high specific heat. Typically the ammonia temperature at the compressor discharge is 250 to 285 degrees F and represents a disadvantage of the system in that the heat must be removed in the condenser. This condenser generally consists of fans and a closed circuit evaporative cooler to remove the heat and discharge it to atmosphere. If, as shown in Figure 1, a shell and tube heat exchanger could be installed with an appropriate bypass and control system between the compresser and evaporative condensor, then hot water up to 150 degrees F could be generated in considerable quantities.

As an example, an ammonia refrigeration unit rated at 200 tons could provide about 650 gallons per hour of water at 150 degrees F assuming an input temperature of 65 degrees F and almost 900 gallons per hour of water at 130 degrees F, assuming the same input temperature. Using the USDA standard of one quart of water per broiler in the scald tanks indicates that this modification would provide hot water for 3600 broilers per hour. In actuality most plants have in excess of 1000 tons of refrigeration which indicates that hot water is available to easily supply in excess of 10,000 broilers per hour. Since all this hot water is not needed as it is produced, it can be stored until needed such as during off shift clean up or start up operations. Again assuming the 200 ton refrigeration system, calculations indicate that savings of over $10,000 a year are possible compared to fuel oil as a boiler fuel. This modification also results in savings from reduced use of fans and water in the evaporative condenser, and the existing system can be utilized by bypassing the heat exchanger when hot water is not needed.

A simpler, although less energy saving, modification in the scald tank is to install a closed circuit heat exchanger instead of sparging steam directly into the scald tanks. The sparging process which is simply bubbling the steam directly into the water is inefficient in that the steam bubbles rise to the surface and give off their remaining heat to the air. Simultaneously, makeup water for the steam boiler is fresh water at 50-60 degrees F and must be heated by the boiler until it becomes steam. If the closed circuit system is used then the scald tank water is heated by coming in contact with the exchanger directly and the cooled steam water is returned to the boiler for reheating. The saving is realized because 180-190 degrees F water is returned to the boiler and a reduced amount of heat is needed to reheat the water from this elevated temperature. A schematic of this system is shown in Figure 2.

In addition to the closed circuit steam, the scald tank overflow water which is discharged at about 125 degrees F at a nominal rate of one quart per bird can be utilized to preheat the incoming makeup water. As the broiler carryout and deliberate overflow water is removed the makeup water which generally enters at 60 degrees F must be heated to the 125 degrees F operating temperature. Shown in Figure 3 is a system whereby a portion of the energy in the output water is transferred to the input water using a simple heat exchanger. This is a simple modification that should pay for itself in 6 to 8 months.

Another simple modification that will reduce energy wastage is to insulate steam, hot water and cold water transmission pipes. The uninsulated pipes are prevalent in many processing plants and the reason generally given is that they must be steam or hot water cleaned at the end of each shift with high pressure steam or water. These conditions are rough on insulation, however, the new metal clad insulation that is commercially available from several insulation manufacturers will alleviate this problem and allow for considerable savings.

During the data acquisition period of this research program many visits were made to poultry processing plants and discussions were held with owners, plant managers and plant engineers for their ideas on ways to conserve energy. Out of these conversations and from personal observation there developed many ideas which have not been thoroughly evaluated by the researchers, but which appear to have obvious energy conserving potential if implemented. These include:

1) Use of jacketed chill tanks in processing plants,
2) Precooling of chill-tank water using mechanical refrigeration and insulated storage tanks,
3) Use of flexible air-lock doors for coolers and freezers,

4) Control of clean up water temperature to set maximum temperature,

5) Turning off of plant lighting during non-operating periods and reducing lighting levels in non-inspection areas, and

6) Enclosure of scald tanks to reduce heat loss.

Of particular interest here is the use of jacketed chill tanks using mechanical refrigeration to maintain the water temperature. When these are used, the water never has to become ice which requires large amounts of energy with its associated inefficiencies in both the freezing and thawing process. Additionally, the losses associated with storage and transportation of the ice are eliminated. As stated, where this and the other listed items have not been definitively analyzed it is obvious that the changes will result in significant energy savings.

A great deal of research has been conducted into limited area broiler brooding by investigators in the Agricultural Research Service Science of the USDA. Twenty five (25) percent reduction in propane consumption has been realized in actual growout tests conducted in facilities at Starkville, Mississippi. From an energy standpoint this concept has considerable merit in that only a limited area of the total broiler house is heated during the first four weeks of a broiler set. Although the broiler growout operation is not in itself energy intensive there are such a large number of them that in relation to the total industry broiler, growers are almost one-third of the energy consumed. Therefore, a 25 percent reduction would become an 8 percent industry usage reduction which is certainly significant from an energy saving standpoint and from the growers' profit standpoint.

In all segments of the industry, investigators observed that the concept of insulating buildings, storage facilities, transmission facilities and the processes themselves was accomplished in an irregular manner. Most processes themselves were open to ambient conditions, many transmission pipes were open and even some buildings and storage facilities were uninsulated. There is a historical reason for this in that when the cost analyses for these facilities were made, energy was extremely inexpensive and therefore not a significant cost factor. As a result, insulation, in many cases, was not an economically viable investment when the equipment was installed or building was constructed. However, now with the increased cost of energy and resulting desire for energy conservation, many decisions not to insulate or to use a limited amount of insulation are economically incorrect. As these analyses cannot be generalized it is recommended that each energy intensive system be completely reanalyzed as to the economic feasibility of insulating or adding additional insulation. This should include items such as ceiling and sidewall building insulation, hot and cold water and steam pipe insulation, window and door infiltration insulation and actual process enclosures such as jacketed chill and scald tanks. With the current cost of energy, payback periods can be quite short for such investments.

Because of a lack of expertise in poultry science, researchers found it necessary during this program to acquaint themselves with at least the rudiments of the science of growing and processing poultry. Conversation and site visits were held with experts in various areas of poultry science from the Cooperative Extension Service and the Agricultural Research Service as well as with many professionally trained members of the industry. One factor that appears to be prevalent in the industry and probably stems from the historical development of the industry is that certain operational procedures have become standard procedures through years of practice and are accepted as operational requirements. Many of these stemmed from methods derived thirty years ago and have not been updated as knowledge about the processes increased, and many of these operational procedures increase energy consumption. An example is the rule of thumb that each broiler requires 0.8 square feet of area in a broiler house. Information from various poultry science researchers indicates that the production of broilers could be accomplished just as efficiently with 0.5 or 0.6 of a square foot of area per bird. Another example is that most broiler growers keep the brooder temperature at 95°F during the first weeks of a set, however, most researchers and some growers get comparable feed conversions with the temperature at 80°F and 85°F. There are other examples of this type of operational disparity throughout the industry.

In trying to rectify some of these differences it became apparent, and this was consistantly verified by poultry science experts and experienced growers, that these "standard operational procedures" were established with very large margins of error to alleviate unexpected deviations from optimum conditions. This was obviously very necessary when the industry was in its infancy, however, now that much more is known about the science and since controls on outside conditions are much more stringent, many of these standard operating procedures are no longer the most efficient way to operate. Therefore it is believed that each organization and each individual concerned with the industry must reevaluate their procedures to see if they still apply in this era of critical and expensive energy.

Through this limited effort much insight by researchers at the Engineering Experiment Station (EES) at Georgia Tech has been gained into the technical aspects of the poultry industry particularly in the energy related areas. It is apparent that much additional work needs to be done in energy conservation particularly in demonstrating modifications and documenting actual savings.

Then these results need to be conveyed to individual entities throughout the industry through publications, training films, workshops and actual technical assistance. A token program has been started at EES to assist the Georgia industry under another grant from the Georgia Department of Agriculture. This program is to choose a number of desirable modifications, demonstrate them under actual operating conditions in a processing plant and document their energy savings, cost and return on investment. However, funds for this program are limited and several large energy savers such as the reject-heat-from-refrigeration modification cannot be demonstrated due to the program's limited funds. Also results of the program will not be disseminated as fast as desirable for the same reason. Therefore, continued and increased efforts are needed in the poultry industry if the industry is to reduce the drag on profits of the continuing increases in the cost of energy.

Appendix A-4

Seminar Presentation Outline

Slide #

1) Introduction

1. 2) Purpose of Study

3) Methodology

2. 1) Breakdown of Industry

2) Scope of Sample

3) Content of Sample

4) Results

3. 1) Industry Energy Use by Types of Fuel

1) Relate BTU's to common parameters

3420 billion BTU's = 37 million gallons propane

= 24 million gallons #6 fuel oil

= 1 billion KWH electricity

= 34 million therms of natural gas

4. 2) Percentage

5. 2) Industry Energy Use by Segments

1) Relate percentage of total

2) Relate energy and cost/unit

6. 3) Georgia Energy Chicken

5) Alternative Forms of Energy

7. 1) Coal Comparison

2) Coal Gassification and Liquification in Future

Seminar Presentation Outline continued

Slide #	
	6) Electric Power Bill Calculations
	1) Explain energy & demand charge
8.	2) Energy charge criteria
9.	3) Demand charge criteria
10.	4) Typical power bill calculation
	Assumption is typical for processing plant
	Note percentages
11.	5) Off-shift operations
12.	7) Energy Conservation Suggestions

POULTRY INDUSTRY ENERGY AUDIT
PROJECT A-1737-004

PURPOSE

SURVEY INDUSTRY TO DETERMINE:

1) AMOUNT OF ENERGY USED
2) TYPES OF ENERGY USED
3) PROCESSES WHICH UTILIZE ENERGY
4) ENERGY RELATED PROBLEMS
5) CRITICALITY OF EACH TYPE OF ENERGY

SLIDE #1

POULTRY INDUSTRY SEGMENTS SURVEYED

1) EGG PROCESSING
2) BROILER PROCESSING
3) FEED MILL
4) HATCHERY
5) BROILER PRODUCER

SLIDE #2

1974 POULTRY INDUSTRY ENERGY USE*

Lectricity	248,739,742.1	Kilowatts	848.7	billion BTU's	24.8%
Iatural Gas	1,409,300,000.	1000 ft^3	1409.3	billion BTU's	41.2%
Fuel Oil	757,042	gallons	107.0	billion BTU's	3.1%
Propane	11,468,478	gallons	1055.0	billion BTU's	30.9%
		Total Energy Used	3420.0	billion BTU's	100%

* Not including transportation

Slide #3

1974 POULTRY INDUSTRY ENERGY COST*

	UNIT COST	$/MILLION BTU'S	BTU'S	COST
CTRICITY	$0.03/KWH	$8.80	848.7 BILLION	$ 7,468,560
URAL GAS	$0.90/1000FT^3	$0.90	1409.3 BILLION	1,268,370
L OIL	$0.35/GALLON	$2.44	107.0 BILLION	261,080
PANE	$0.40/GALLON	$4.35	1055.0 BILLION	4,589,250
		TOTAL	3420.0 BILLION	$13,587,260

GHTED AVERAGE COST PER MILLION BTU'S = $3.97

OT INCLUDING TRANSPORTATION

SLIDE #4

1974 POULTRY INDUSTRY ENERGY USE BY SEGMENTS*

SEGMENT	ENERGY USE BTU'S	BTU/UNIT	COST/UNIT	PERCENT
)ILER PROCESSOR	1372 BILLION	3320/BIRD	1.10¢/BIRD	40
; PROCESSOR	104 BILLION	226/DOZ	0.15¢/DOZ	3
ED MILL	720 BILLION	330,000/TON	$1.15/TON	21
TCHERY	128 BILLION	310/CHICK	0.17¢/CHICK	4
)ILER PRODUCER	1096 BILLION	2660/BIRD	1.24¢/BIRD	32
TOTAL	3420 BILLION			

NOT INCLUDING TRANSPORTATION

SLIDE #5

GEORGIA ENERGY CHICKEN

	ENERGY	COST*
LAYER	19 BTU'S	0.013¢
HATCHERY	310 BTU'S	0.170¢
BROILER PRODUCER	2700 BTU'S	1.240¢
BROILER PROCESSOR	3320 BTU'S	1.100¢
FEED	1320 BTU'S	0.460¢
TOTAL	7669 BTU'S	2.983¢

*NOT INCLUDING TRANSPORTATION COSTS

SLIDE #6

NATURAL GAS/COAL COST COMPARISON

SSUMPTIONS:	NATURAL GAS	COAL
quipment Cost	\$10,000	\$100,000
quipment Life	20 years	10 years
perating & Maintenance	0.5 mh per day	16 mh per day
abor Cost	\$3 per hour	\$3 per hour
nergy Use (Processing Plant)	48.8 billion Btu's	48.8 billion Btu's
uel Heating Valve	1,000,000Btu/1000 ft^3	28 million Btu/ton
uel Requirement (Processing Plant)	48,000-thousand ft^3	1740 tons

BREAKEVEN COSTS

COAL	NATURAL GAS
\$ 6.25/ton	\$0.90/1000 ft^3
40.00/ton	2.10/1000 ft^3
50.00/ton	2.45/1000 ft^3
60.00/ton	2.82/1000 ft^3
100.00/ton	4.25/1000 ft^3

SLIDE #7

TYPICAL POWER BILL CALCULATION

ENERGY CHARGE CRITERIA
(Schedule "I-3")

First 400 KWH per KW of Demand		
First 1,000,000 KWH	@ - - - - - - - -	$0.0065 per KWH
Additional KWH	@ - - - - - - - -	$0.0050 per KWH
All KWH over 400 KWH per KW of Demand		
	@ - - - - - - - -	$0.0040 per KWH

SLIDE #8

TYPICAL POWER BILL CALCULATION

DEMAND CRITERIA
(Schedule "I-3")

Demand is based on highest 30-minute kilowatt consumption during current month and preceding eleven (11) months

MONTHS OF:		
June July August September	Greatest of:	1) Current Demand 2) 95% of highest demand in previous summer months 3) 60% of highest demand in previous winter months

MONTHS OF:		
October thru May	Greatest of:	1) 95% of highest demand in previous summer months 2) 60% of highest demand in previous winter months including current month

SLIDE #9

TYPICAL POWER BILL CALCULATION
(Normal Day Shift Operation)

Assumptions: Month of July USAGE = 510,000 KWH
Demand = 1400 KW Reactive Demand = 1200 KVAR
Industrial Power Schedule "I-3"

ENERGY CHARGE

KWH/KW = 510,000/1400 = 365

Therefore Energy Charge = (510,000)($0.0065) =	$3320	42.5%

DEMAND CHARGE

Demand Charge = $470 + ($3.35)(900 KW) + ($2.35)(400 KW) =	$4410	56.5%

REACTIVE DEMAND CHARGE

Reactive Demand Charge = ($0.15)(1200-(0.5)(1400)) =	$ 75	1%
Total Power Charge =	$7805	

SLIDE #10

TYPICAL POWER BILL OPERATION
("off-peak" Rider)

Assumptions: Month of July — Usage = 510,000 KWH
Demand = 1400 KW — Reactive Demand = 1200 KVAR
Industrial Power Schedule "I-3"

With "off-peak" rider all months are treated as winter months. Therefore, demand = highest 60% of current and past 11 months

Demand = (.6) (1400 KW) = 840 KW

ENERGY CHARGE

KWH/KW = 510,000/840 = 608

First 400 KW Demand = (400)(840) = 336,000 KWH
Therefore, Energy Charge = (336,000) ($0.0065) + (174,000) ($0.0040) = $2880 49%

DEMAND CHARGE

Demand Charge = $470 + ($3.35) (740) = $2949 50%

REACTIVE DEMAND CHARGE

Reactive Demand Charge = ($0.15) (1200-(0.5) (1400)) = $ 75 1%

Total Power Charge = $5904

SLIDE #11

GEORGIA POULTRY INDUSTRY

ENERGY CONSERVATION SUGGESTIONS

1) Use scald tank overflow as a heat source

2) Consider closed circuit steam heating of scald tanks to replace sparging

3) Use compressor exhaust as heat source

4) Consider jacketed chillers and prechilled water

5) Consider off-peak ice machine operation

6) Consider flexible, air-lock door for coolers and freezers

7) Consider limited area brooding for young broiler chicks

8) Institute tighter operational controls on heat intensive processes

9) Off-shift operations

SLIDE #12